PLANNING GUIDELINES FOR
VILLAGE AFFORESTATION IN TANZANIA

BY

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STATEMENT OF ORIGINALITY

Except where otherwise indicated, the work reported in this thesis is the original work of the author.

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ABSTRACT

The objective of this study is to formulate general planning guidelines for village afforestation in Tanzania. The study commences with a review of literature on the use of fuelwood and establishment of community forestry in developing countries. Experience gained in these countries could provide useful guidelines for solving the problems encountered in Tanzania.

Fuelwood will continue to be the main source of domestic energy in Tanzania in the near future. Acute shortages of fuelwood and small wood materials are inevitable due to the amount and intensity of clearing of natural forests. The fuelwood scarcity will render more serious a number of socio-economic problems, mainly soil degradation accompanied by a reduction in agricultural production, which could lead to food shortages for the rapidly increasing population.

Intensive tree planting throughout the country must be undertaken as an integral part of socio-economic development. This could be achieved by making the national and village leaders aware of the benefits of forests and forest products as part of balanced development and by establishing an effective cadre of trained extension workers who can communicate effectively with village people the benefits of, and methods for, developing village forestry.

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CHAPTER 1

INTRODUCTION TO THE STUDY

1.1 Objectives and format of the study

The objective of this study is to formulate general planning guidelines which can be used for successful village afforestation in Tanzania. This objective will be furthered by following the pattern outlined below.

(a) Review literature on the use of fuelwood and establishment of community forestry in developing countries. Experience gained in these countries might be useful in providing guidelines to solve the problems encountered in Tanzania.

(b) Briefly review renewable energy sources which can supplement fuelwood in the future.

(c) Analyse current approaches to village afforestation in Tanzania.

(d) Outline planning guidelines which should be considered for successful implementation of village afforestation. The recommendations are influenced by the author's 10 years experience in village afforestation in Tanzania.

Village afforestation is a government based rural development program in Tanzania, organised to foster self reliance. Farmers are encouraged to plant trees either on a communal basis or individually in order to meet the future requirement for fuelwood and small wood materials. Currently such products are in acute shortage and farmers are facing many difficulties in obtaining them. The government provides free seedlings and technical advice while the villagers provide land and free labour. However, the products of village afforestation are appropriated by the villagers concerned. If the program is successful, it is expected to minimise the current rate of deforestation and desertification taking place in Tanzania as well as accelerate socio-economic development in rural areas.

1.2 Background information

The main economic and social aspects of Tanzania are discussed briefly in order to provide a background for analysing the contribution of village afforestation and forestry in general to the socio-economic development of the nation. Forestry provides many of the basic needs required by the majority of the population. Wood is a renewable resource which can be produced locally with intensive use of land and labour and with relatively small capital.

1.2.1 General features of Tanzania

Tanzania has a total land area of 887,000 square kilometres and a population of 17,500,000 people (1978 census) with an average population growth of 3.4 percent per annum. Of the total population in 1978, 46 percent were under the age of 15 years. The annual crude birth rate is about 48 per thousand and the death rate 20 per thousand. Life expectancy is about 46-50 years. The highest population densities reach more than 250 persons per square kilometre on the fertile lower slopes of Mount Kilimanjaro, on the shores of Lake Nyasa, and in some areas along Lake Victoria in Mwanza and West Lake regions (Figure 1.1). About 75 percent of the population live on the periphery of the country, the central part being sparsely populated. The urban population is estimated to be about 10 percent of the total population. The largest single urban population is in Dar es salaam (830,000), the government and commercial centre of Tanzania. Table 1.1 shows the population of Tanzania by regions (1978 census).

Table 1.1

Population of Tanzania by Regions (1978 census)

	Region	Total Population	Growth Rate Percent	Density Sq. km.
1	Arusha	922,152	4.0	11.4
2	Coast	514,363	1.7	15.9
3	Dar es salaam	830,448	8.6**	624.6
4	Dodoma	967,649	2.9	23.5
5	Iringa	919,752	2.7	16.2
6	Kigoma	647,610	2.9	17.5
7	Kilimanjaro	902,194	3.1	68.7
8	Lindi	521,293	2.2	8.1
9	Mbeya	1,074,981	3.3	17.9
10	Mara	721,238	2.6	33.7
11	Morogoro	931,391	2.9	13.3
12	Mtwara	771,251	2.0	46.2
13	Mwanza	1,441,605	2.9	73.4
14	Rukwa	451,700	4.4	65.0
15	Ruvuma	561,433	3.3	8.8
16	Shinyanga	1,322,130	3.6	26.1
17	Singida	615,804	2.7	12.5
18	Tabora	814,734	4.6	10.8
19	Tanga	1,029,603	2.7	38.5
20	West Lake	1,007,356	4.0	35.5
21	Zanzibar	479,655	*	*
	Total	17,448,342		1167.6
	Average	830,873	3.4	58.4

Source: Bureau of Statistics, Dar es salaam

* Data not available

** People move into the region due to industrial developments.

The population of Tanzania in 1967 census was 12 million.

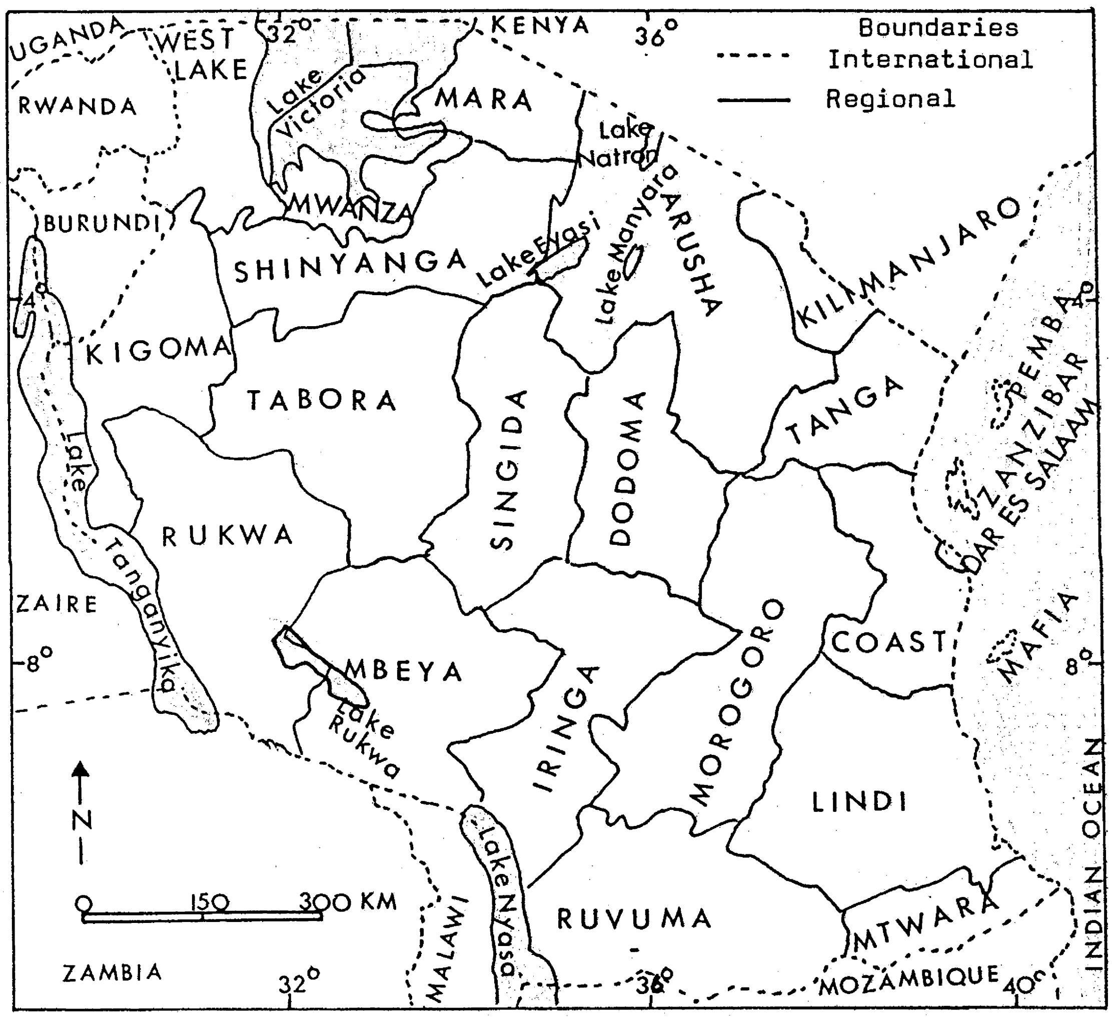
The country has a wide variety of land forms which includes the highest peak in Africa, Mount Kilimanjaro (5,950m.) and the lowest part of Africa at the floor of Lake Tanganyika (358m. below sea level). The main upland areas occur in a northern belt, the Meru, Kilimanjaro, Pare and Usambara mountains, a central and southern belt which covers Ngorongoro, Hanang, Southern highlands and Uluguru mountains. Much of the rest of inland Tanzania is made up of sloping plains and plateaux broken only by low hill ranges and scattered isolated hills.

The coast includes areas with sweeping sandy beaches with developed coral reefs which are broken by extensive growth of mangrove forests.

Rainfall is variable. About 21 percent of the country can expect more than 750mm of rainfall, but only about 3 percent can expect more than 1,250mm per annum. A large part of the country is rather dry; mainly the central portion with rainfall less than 600mm and evaporation exceeding rainfall for nine months of the year. A rainy season from December to April is common throughout the country except along the mountainous areas where two peaks of rainfall, in October to November and April to June, are experienced.

Figure 1.1

Map of Tanzania



The economy of the country is based mainly on the agricultural sector, which contributes about 40 percent of the GNP and approximately 80 percent of the export trade. Table 1.2 shows export statistics for Tanzania for 1974 and 1975 for principal commodities. More than 90 percent of the population live in the rural areas, engaged mostly in agriculture. Cash crops include coffee, cotton, tobacco, tea, cloves and sisal. Food crops include mainly maize, wheat, rice, millet, potatoes and bananas.

The industrial sector in Tanzania is still small, accounting for about 10 percent of the total GNP. Most of the few existing industries are agro-allied, ie. textile mills, farm implement industries and forestry industries. Some small scale industries using low technology are established in rural areas close to sources of supply of raw materials. Income per capita per annum is about US $150.

For the past 10 years the trade balance in Tanzania has been negative (Table 1.3) and the situation is worsening year by year. This is due to the fact that Tanzania must accept the going price for all of its primary products exported to the world market. The real value of Tanzanian products has been declining since 1970 and the situation was made worse by the 1973 oil crisis. For example, in 1970 Tanzania could export 4 tonnes of sisal to purchase one farm tractor, but by 1979 Tanzania had to export 12 tonnes of sisal to purchase the same tractor, while running and maintenance costs of the tractor have also increased significantly. The same trend applies to all primary goods exported by Tanzania.

Table 1.2

Export Statistics for Tanzania 1974 and 1975
for Principal Commodities

Export	Million US $ 1974	1975
Coffee beans	45.2	58.2
Raw cotton	57.0	35.8
Diamonds	14.7	21.5
Sisal	55.8	36.4
Cloves	23.6	21.3
Tobacco	10.6	9.9
Residual fuel oils	9.3	9.3
Cordage, rope and twine of sisal	17.5	10.6
Tea	8.3	9.8
Forest products	1.7	1.6
Pepper and pimento (including chillies)	8.3	9.8
Others	53.8	81.1
Total	305.8	305.3

Source: Bureau of Statistics, Dar es salaam

Table 1.3

Summary of Trade Balance for Tanzania 1966-1975 (million US $)

Year	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Export	226.3	212.1	199.6	197.6	206.4	214.1	244.0	277.4	327.6	293.2
Import	203.8	195.8	221.0	199.9	268.9	322.7	338.1	410.8*	618.9*	653.4*
Trade balance	22.5	16.3	-21.4	-2.3	-62.5	-108.6	-94.1	-133.4	-291.3	-360.2

Source: World Bank 1977

* The increase is mainly due to oil price rise effects.

1.2.2 Social and rural development

The prevailing social and economic factors in Tanzania, a few of which are referred to above, influenced the country in 1967 to pursue a socialistic policy in its development strategy. Since 90 percent of the population (Table 1.4) is living in rural areas, immediate attention was focused on the type of rural development to be adopted. As most of the rural population were either leading nomadic lives or living in widely scattered homesteads, socialisation of the rural life was started by re-settling the rural population into planned and permanent villages. About six years were spent in educating the rural people about the need to change their nomadic type of life and to settle in permanent villages where social and economical facilities could be provided to them more efficiently. By 1978 all rural populations in Tanzania were settled in planned permanent villages. A total of 8,200 villages were registered with a population of approximately 13.8 million people.

Table 1.4

Distribution of Labour Force in Tanzania (1975)

Sector	Population (millions)	Percentage to the total population (labour force)
Agriculture	5.3	91.0
Industry	0.1	2.0
Services	0.4	7.0

Source: Bureau of Statistics, Dar es salaam

The rural socialisation was accompanied by the provision of health, education, clean water and other social services to villagers. For the people at the grass roots level, political independence gained in 1961 would have not meant anything to them if they were to have continued living under the scourges of illiteracy, disease and poverty. Eradication of these scourges became the objectives of rural development. It has been taken for granted that broadly-based developments may be difficult or impossible if the majority of the population continue to remain illiterate and troubled by some of the most debilitating diseases.

In the war against illiteracy reasonable success has been achieved as outlined below. The school system has been expanded greatly to maintain and improve the proportion of children receiving education, a massive task given the past birth rates.

(a) The number of pupils enrolled in primary schools increased from 486,400 in 1961 to 2,968,700 pupils in 1978, an increase of 510 percent.

(b) The number of pupils enrolled in standard one (first grade) increased from 125,500 in 1962 to 947,800 in 1978, an increase of 655 percent.

(c) The number of adult men and women attending literacy classes increased from nil in 1961 to 3,650,000 in 1977. In August 1977 a total of 2,346,100 adults who had attended literacy classes during the previous years took their examinations.

(d) Enrolment for secondary school increased from 13,000 in 1961 to 46,000 in 1971, an increase of 254 percent.

In the war against disease the following has been achieved:

(a) The number of beds in hospitals, dispensaries and rural health centres has increased from 11,900 in 1962 to 32,300 in 1977, an increase of 171 percent.

(b) The number of outpatients treated in hospitals, dispensaries and rural health centres increased from 22,056,000 in 1962 to 97,340,000 in 1977, an increase of 341 percent. Preventive measures are emphasised rather than curative. Most of the health services are located in the rural areas.

(c) Clean water has been provided in many villages.

In general, a great deal of effort has been put into spreading education and health services to as large a segment of the population as the economic situation of the country allows. The forestry sector has contributed significantly to this development by providing wood raw materials for the construction of buildings and for making furniture. However, the increase in the provision of social services has also had to cope with a population growth of 3.4 percent per annum.

1.2.3 Village government

In 1975 village governments were established with legal status. The main organs of village government are the village assemblies. Every resident of a village who is eighteen years and above is a member of the village assembly. The executive of the village assembly is the village council which consists of twenty five members elected democratically every five years by the village assembly. In addition to the twenty five members of the village council the executive machinery of the village consists also of a village chairman who is the leader of the village council, a treasurer and a secretary, who are also elected by the village assembly.

The village council is divided into five committees. Each committee consists of at least five members of the village council. Additional members are sometimes co-opted from the village assembly depending on the activeness of the committee.

The committees are:

(a) Finance and planning
(b) Production and marketing
(c) Education, culture and social services
(d) Communication and works
(e) Defence and security.

In general, the responsibilities of the different committees and the village council in total are as outlined below.

(a) To undertake any activities for the economic and social development of the village.
(b) To plan, co-ordinate and assist the residents of the village engaged in agriculture, forestry and other industrial activities.
(c) To encourage the residents of the village in undertaking and participating in communal enterprises such as communal farming, establishment of village forest plantations and co-operative shops.
(d) To participate in economic enterprises in co-operation with other village councils.

The village councils, on behalf of the village assemblies, are empowered to raise their own funds, engage personnel and make their own rules. Government workers are posted to villages to assist the village councils in carrying out their functions. Government workers in villages are completely answerable to their respective village councils for their performance.

Villages are therefore the basic units of rural development in Tanzania, and villagers are the principal initiators and implementors of development plans within their villages, with constant advice from the government. Future establishment of village forest plantations for village use depends largely upon the effectiveness of the villagers themselves in establishing and managing such forests.

National plans are based on development plans brought forward by villagers. Individual village plans are sent to district headquarters where they are combined with other village plans within the district. District plans are then compiled and sent to the regional headquarters. Regional plans are compiled and sent to the national planning team where national plans are compiled. The administrative mechanism works from the village upwards. This type of organisational structure assists in ensuring that basic needs urgently required by the majority of the people are given priority in all development plans for the nation.

1.2.4 Agricultural expansion

Economic growth and self-sufficiency in food for the villagers and the nation as a whole depend heavily on increased production in the agricultural sector. Increased production is expected to be achieved through intensification of the area already under cultivation and by area expansion. With the population increase at 3.4 percent per annum, more food is required each year. From 1970 to 1979, the closest approach to self-sufficiency in food attained by the nation was only 65 percent. A substantial amount of foreign currency is spent each year to import food which could be grown in Tanzania (Table 1.5). Obviously food production could be much greater if there were fewer cash crops such as tobacco and sisal. The question is whether Tanzania is better off to export cash crops and import food or some other combination of the possibilities. This is an area which requires immediate investigation.

Table 1.5

Food Importation in Tanzania

Imports	Million US $ 1974	1975
Wheat	11.6	19.4
Rice	32.3	28.8
Maize	42.4	34.5
Total	86.3	82.7

Source: Bureau of Statistics, Dar es salaam

Clearing of forests for agricultural expansion has reduced significantly the amount of forested land in Tanzania. According to land use statistics, Tanzania has a forest land area of 31,074,000 hectares of which 12.7 million hectares are demarcated as forest reserves. The forest reserves are partially protected by law but the remaining forests are not protected and they are the ones cleared for agricultural expansion, for fuelwood and for other small wood material supply. Table 1.6 shows the agricultural land use statistics for Tanzania in 1976.

Table 1.6

Agricultural Land Use Statistics for Tanzania 1976

Land Use	Area ('000 hectares)
Arable land	5,200
Land under permanent crops	1,090
Permanent meadow and pasture	44,720
Forests and woodland	31,074
Other land	6,520
Inland water	5,905
Total	94,509

Source: Mnzava 1980

1.2.5 Livestock industry

Tanzania has a large population of livestock which is concentrated in a small portion of the country, mainly Arusha, Dodoma, Shinyanga and Singida (Table 1.7). Overgrazing is quite pronounced in the livestock area. The recommended cattle grazing capacity in most grazing regions is 4 hectares per stock unit but in practice the figure is as low as 0.5 hectare per stock unit. Hence there are serious overgrazing problems. Productivity of thousands of hectares of land is severely reduced each year through soil erosion caused mainly by overgrazing. Government requests to graziers to reduce the number of cattle by selling some have not yet been successful. (The drop between 1977 and 1978 indicated in Table 1.7 was caused by drought). Increased productivity of grazing land per unit area mainly by planting fodder trees will minimise the destruction of forests (Appendix 1).

Table 1.7

Livestock Population in Tanzania 1975 to 1978

	(thousands) 1975	1976	1977	1978
Cattle	13,882	14,362	14,817	11,647
Sheep	2,900	2,950	3,000	2,371
Goats	4,600	4,700	4,700	4,059
Pigs	24	24	25	*
Asses	160	160	160	*
Chickens	19,000	19,300	20,700	*
Ducks	2,300	2,350	2,400	*

Source: Bureau of Statistics, Dar es salaam

* Data not available

1.2.6 The role of forestry in Tanzanian social economic development

The major contribution of the forestry sector in the Tanzania economy is the provision of fuelwood as a source of domestic energy. Fuelwood accounts for 94 percent of the total energy used in Tanzania including energy for commercial purposes (Howe and Gulick 1980). About 98 percent of the population rely upon fuelwood as their source of domestic energy; to cook food and for heating purposes (Openshaw 1978). The average consumption of fuelwood in Tanzania per capita per annum is about $2.3m^3$ (Howe and Gulick 1980). In rural areas fuelwood is collected freely from nearby forests. The only cost involved is the time spent collecting the fuelwood. Ten years ago fuelwood sufficient for one day could be collected within one or two hours, but now fuelwood collection is taking longer and longer as distances to fuelwood supply become greater.

Fuelwood and charcoal account for 97 percent of the total forest products consumed in Tanzania (Table 1.8). Although fuelwood is mainly collected freely from natural forests, it does have a real value. This value is estimated in monetary terms in Table 1.8 in an attempt to find the real economic value if this fuelwood were purchased at stump, excluding transport costs.

The natural forests contribute about 99.87 percent of the total fuelwood consumed in Tanzania, plantations contribute only 0.13 percent (Table 1.8). One hectare of woodland in Tanzania can produce approximately $50\text{-}60m^3$ of roundwood when clearfelled (Temu 1979). Based on total roundwood consumed for fuelwood and charcoal (Table 1.8) it can be estimated that more than 500,000 hectares of woodland are cleared each year in Tanzania for provision of fuelwood and charcoal. Natural regeneration of the cleared woodlands is rare (Kaale 1979a). Methods of regenerating the cleared woodlands artificially are not known by foresters and the cleared woodlands become grassland. Thus a severe shortage of fuelwood in the future is inevitable unless intensive tree planting is undertaken to replace the cleared woodlands.

Tanzania will face a severe economic burden if the country attempts to replace wood fuel with other imported commercial fuels. Currently the country is spending over US $180 million for imported oil which accounts for less than 3 percent of the total energy used in the country (commercial and domestic). If the country were to import the 94 percent of the energy provided by fuelwood, it would need to spend, on average, US $5,640 million in addition to the US $180 million used now for importing oil. With the negative trade balance currently being experienced by Tanzania (Table 1.3) this is quite impossible. It is obvious that intensive tree planting to meet future requirements of fuelwood is an essential aspect of socio-economic development for Tanzania.

Forestry also contributes industrial roundwood for construction and other development projects. Industrial roundwood includes poles, sawlogs, veneer logs and woodchips. The average consumption of industrial roundwood in Tanzania is currently about $0.06m^3$ per capita per annum. The consumption has declined from $0.08m^3$ in 1966 to $0.06m^3$ in 1978, a drop of 25 percent (Table 1.9). The decline is mainly caused by unavailability of wood associated with the intensive clearing of the natural forests without subsequent regeneration. The natural forests contributes 94 percent of the total industrial roundwood used in Tanzania.

Table 1.8

Production of Fuelwood and Charcoal in Tanzania in relation to Other Forest Products (Roundwood $1000m^3$)

Year	Total production of all forest products	Total production of fuelwood and charcoal	Percentage of fuelwood and charcoal to the total production of all forest	Percent of fuelwood and charcoal removed from natural forests	forest plantations	Estimated value of the fuelwood and charcoal in million US $ *
1966	28,009	27,100	97	99.81	0.19	81.3
1967	28,730	27,800	97	99.82	0.18	83.4
1968	29,477	28,500	97	99.82	0.18	85.5
1969	30,525	29,500	97	99.83	0.17	88.5
1970	31,595	30,500	97	99.84	0.16	91.5
1971	32,132	31,000	96	99.84	0.16	93.0
1972	32,672	31,300	96	99.84	0.16	93.9
1973	33,034	32,087	97	99.84	0.16	96.3
1974	35,378	34,481	97	99.86	0.14	103.4
1975	36,444	35,557	98	99.86	0.14	106.7
1976	37,526	36,675	98	99.86	0.14	110.0
1977	38,722	37,834	98	99.87	0.13	113.5
1978	40,039	39,037	97	99.87	0.13	117.1

Source: FAO 1980

* The price of $1m^3$ of roundwood for fuelwood was about US $3 at stump in 1978 (Kaale 1979a).

Table 1.9

Production Summary of Industrial Roundwood

Year	Total production ($1000m^3$)	Imports ($1000m^3$)	Export ($1000m^3$)	Net volume available for home consumption ($1000m^3$)	Population (millions)	Consumption per capita (m^3)	Estimated monetary value (million US $) at stump *
1966	909	-	6	903	11.0	0.08	5.40
1967	930	1	4	927	11.9	0.08	5.56
1968	977	8	4	981	12.4	0.08	5.89
1969	1,025	10	9	1,026	12.6	0.08	6.16
1970	1,095	22	11	1,106	12.9	0.08	6.64
1971	1,132	55	18	1,169	13.3	0.09	7.01
1972	1,172	4	3	1,173	13.6	0.09	7.04
1973	975	5	3	977	14.7	0.07	5.86
1974	929	3	3	929	15.2	0.06	5.57
1975	942	3	3	942	15.7	0.06	5.65
1976	930	3	3	930	16.2	0.06	5.58
1977	992	3	3	992	16.8	0.06	5.95
1978	1,002	3	3	1,002	17.4	0.06	6.01

Source: FAO 1980

* Price of $1m^3$ roundwood at stump was on average US $6 in 1978.

The average consumption of sawlogs and veneer logs in Tanzania per capita per annum is currently about $0.01m^3$. The consumption dropped from $0.03m^3$ in 1970 to $0.01m^3$ in 1978, a decline of 67 percent (Table 1.10). The consumption is expected to decline even further in the near future due to the declining supply of sawlogs and veneer logs from the natural forests. However, intensively managed, fast growing, softwood plantations, which by 1978 totalled 19,070 hectares, are expected to minimise future sawn timber shortage in the country. The annual planting target for softwood plantations is about 4,000 hectares, using mainly Pinus patula, Pinus caribaea, Pinus elliottii and Cupressus lusitanica.

Consumption of poles in Tanzania per capita per annum has remained constant for the past 15 years from 1966 to 1980, with an average consumption of $0.05m^3$. However future availability of poles from the natural forests is not assured (Table 1.11).

Due to the educational development currently taking place in the country, the consumption of paper and paper boards per capita per annum has increased from 0.0005 metric tonne per capita in 1966 to 0.0011 metric tonne in 1978, an increase of 120 percent. However, the country imports all its paper and paper board which accounts for 87 percent of all forest products imported by Tanzania. This is contributing significantly to the forest products trade balance deficits (Table 1.12).

Table 1.10

Production Summary of Sawlog and Veneerlogs

Year	Total production ($1000m^3$)	Imports ($1000m^3$)	Export ($1000m^3$)	Net volume available for home consumption ($1000m^3$)	Population (millions)	Consumption per capita (m^3)
1966	340	-	1	339	11.0	0.03
1967	350	-	1	349	11.9	0.03
1968	387	-	1	386	12.4	0.03
1969	400	-	4	396	12.6	0.03
1970	440	-	4	436	12.9	0.03
1971	470	-	10	460	13.3	0.03
1972	500	-	2	498	13.6	0.04
1973	261	-	2	259	14.7	0.02
1974	193	-	2	191	15.2	0.01
1975	183	-	2	181	15.7	0.01
1976	147	-	2	145	16.2	0.01
1977	184	-	2	182	16.8	0.01
1978	168	-	2	166	17.4	0.01

Source: FAO 1980

Table 1.11

Summary of Poles Production

Year	Total production ($1000m^3$)	Imports ($1000m^3$)	Export ($1000m^3$)	Net volume available for home consumption ($1000m^3$)	Population (millions)	Consumption per capita (m^3)
1966	569	-	4	565	11.0	0.05
1967	580	-	2	578	11.9	0.05
1968	590	7	3	594	12.4	0.05
1969	625	10	6	629	12.6	0.05
1970	655	22	7	670	12.9	0.05
1971	662	55	8	709	13.3	0.05
1972	672	4	1	675	13.6	0.05
1973	714	5	2	717	14.7	0.05
1974	736	3	1	738	15.2	0.05
1975	759	3	1	761	15.7	0.05
1976	783	3	1	785	16.2	0.05
1977	808	3	1	810	16.8	0.05
1978	834	3	-	837	17.4	0.05

Source: FAO 1980

Table 1.12

Summary of Forest Products Trade Balance for Tanzania

Year	Export (US $1000)	Import (US $1000)	Trade Balance (US $1000)
1966	2,131	2,766	- 635
1967	1,661	3,017	- 1,356
1968	2,070	3,693	- 1,623
1969	3,394	3,921	- 527
1970	2,317	5,402	- 3,085
1971	2,284	6,546	- 4,262
1972	897	5,019	- 4,122
1973	1,692	7,993	- 6,301
1974	1,746	13,883	-12,137
1975	1,583	13,883	-12,300
1976	1,734	13,883	-12,149
1977	1,526	13,883	-12,357
1978	1,618	13,883	-12,265

Source: FAO 1980

To meet the rising demand of paper and paper boards from within the country's resources, a pulpmill is currently under construction in Tanzania and is expected to start production by early 1981. The production capacity of the pulpmill is expected to be large enough to meet local demand. Of the 4,000 hectares of Government plantation to be established in Tanzania each year, 3,000 hectares will be for the pulpmill. The pulpmill will also provide a market for village softwood plantations, mainly to those villages located near the mill.

The forestry sector provides direct employment to about one percent of the total population in Tanzania, mainly in rural areas where alternative industrial employment is not available. Forestry also provides many intangible benefits to rural people like better water catchments, stabilisation of soil and amelioration of climate, recreation and establishment of many development infrastructures in rural areas, such as roads, health services, schools, electricity, clean water and communication systems. Telephone and radio become available both to the forest workers and to the rural population.

Forestry is therefore contributing significantly to the current socio-economic development of Tanzania by providing some of the basic needs required by the majority of the population. However, as stated earlier, the natural forests which contribute more than 95 percent of the total forest products consumed in the country are declining, in fact they are vanishing at a fast rate. To meet future demand, immediate and intensive nationwide tree planting is vital if the country is to continue to achieve meaningful socio-economic development.

1.2.7 Meeting future demand of forest products

The country is planning to meet its future demand for fuelwood and small wood materials through village afforestation, industrial roundwood through intensively managed plantations and some of the intangible benefits like improvements of water catchments by conserving the existing natural forests more effectively.

So far the establishment of intensively managed plantations is progressing successfully. However, the implementation of village afforestation is not yet successful. Up to 1979, over 22,000 hectares of fuelwood plantation were already planted in different villages (Table 1.13). The success rate in the establishment of these plantations has been below 30 percent due to the unwillingness of villagers to tend and protect the planted trees. Successful implementation of future village afforestation will therefore depend on proper initial planning on how to overcome problems experienced in the implementation of village afforestation.

Table 1.13

Planted Area for Village Afforestation 1973-1979

Year	Number of hectares planted
1973	1,066
1974	1,388
1975	1,634
1976	1,536
1977	3,278
1978	6,086
1979	8,003
Total	22,991

Source: Tanzania Forest Division 1980

CHAPTER 2

THE USE OF FUELWOOD IN DEVELOPING COUNTRIES

2.1 Fuelwood as the main source of domestic energy

Fuelwood is the main source of domestic energy in developing countries for both rural and urban households. Arnold and Jongma (1978) state that more than 86 percent of all the wood consumed annually in developing countries is used as fuelwood. Fuelwood accounts for 66 percent of all energy, other than human and animal energy, used in Africa and for 33 percent in Asia. Table 2.1 shows per capita consumption of fuelwood in some developing countries as well as the fuelwood consumption as a percentage of total energy used. The data demonstrate clearly the heavy dependence on fuelwood in these countries.

Table 2.1

Per capita consumption of fuelwood in some developing countries
(m^3 roundwood equivalent)

Country	Year of survey	Population (millions) 1977	Fuelwood consumption m^3 per capita	Fuelwood consumption as a % of total energy used in the country
Algeria	1976	17.0	0.07	4
Angola	"	6.6	1.06	74
Benin	"	3.2	0.69	86
Burundi	"	4.2	0.22	89
Cameroon	"	7.9	1.00	82
Central African Republic	"	1.9	1.01	91
Chad	"	4.2	0.80	94
Congo	"	1.4	1.30	80
Ethiopia	"	30.2	0.81	93
Gabon	"	0.5	2.33	44
Gambia	"	0.6	0.48	73
Ghana	"	10.6	1.04	74
Guinea	"	5.0	0.60	74
Guinea Bisseau	"	0.6	0.86	87
Ivory Coast	"	7.5	0.76	46
Kenya	"	14.6	0.99	74
Liberia	"	1.7	1.09	53
Libya	"	2.6	0.20	5
Madagascar	"	8.1	0.66	80
Malawi	"	5.6	0.60	82
Mali	"	6.1	2.20	97
Mauritania	"	1.5	0.40	63
Mauritius	"	0.9	0.02	2
Morocco	"	18.3	0.15	19
Mozambique	"	9.7	0.88	74

Table 2.1 (continued)

Country	Year of survey	Population (millions) 1977	Fuelwood consumption m^3 per capita	Fuelwood consumption as a % of total energy used in the country
Niger	"	4.9	0.55	87
Nigeria	"	79.0	0.99	82
Rwanda	"	4.4	0.88	96
Senegal	"	5.2	0.61	63
Sierra Leone	"	3.2	0.81	76
Somalia	"	3.7	1.02	90
Sudan	"	16.9	1.39	81
Tanzania	"	16.4	2.35	94
Togo	"	2.4	0.40	67
Tunisia	"	5.9	0.30	22
Uganda	"	12.0	1.14	91
Upper Volta	"	5.5	0.63	94
Zambia	"	5.1	1.02	45
Zaire	"	25.7	0.46	76
Thailand	1972	36.0	1.36	*
India	1970	574.2	0.38	30.3
Nepal	1976	12.0	0.53	95.8

Source: Howe and Gulick 1980, Cecelski et al 1979, Shepherd 1979, Earl 1975.

NB. Energy value calculated on the basis of $2.3m^3$ of wood equals 1 metric tonne of coal equivalent.

* Data not available.

2.2 Consumption of fuelwood

Consumption of fuelwood in developing countries varies significantly from country to country. The main reasons why poor people rely upon fuelwood, and the factors leading to these variations in fuelwood consumption are discussed in this section.

2.2.1 Consumption data

Low income and poverty are the main factors forcing most people in developing countries to rely heavily upon fuelwood as their source of domestic energy. Fuelwood can be used with simple, cheap stoves (even without a stove at all) and with locally manufactured pots. Openshaw (1978) stated that fuelwood consumption data are not kept by many developing countries as it is freely collected from the forest. Fuelwood consumption surveys presents some difficulties as consumption varies with the season of the year and availability of food. This author indicated that in many developing countries, collection of fuelwood and cooking is done by women who are rather shy and reluctant in giving details of the amount of fuelwood they use for cooking and for other domestic purposes. Women attempting to obtain this information will obtain fuelwood consumption data more easily than men from their own sex.

Openshaw (1978) also indicated that due to some of the above factors, many fuelwood surveys underestimate consumption. To minimise the problem of underestimating consumption, he recommended consumption surveys should be done continuously throughout the year from individual households. Some consumption data of fuelwood are given in Table 2.1. Consumption per capita varies significantly from $2.35m^3$ for Tanzania to $0.22m^3$ for Burundi. The variation is suspected to be caused mainly by the availability of free fuelwood to villagers within walking distance, climatic factors and cooking habits. It is forecast Burundi will become bare of trees in seven years unless massive tree planting programs are undertaken.

The high fuelwood consumption figures for Tanzania ($2.35m^3$ per capita per annum) which correspond to those of Gabon ($2.33m^3$) and Mali ($2.20m^3$), are suspected to have been overestimated. However, Fleuret and Fleuret (1978), who carried out an intensive fuelwood survey in Tanzania, came up with an even higher figure of $2.60m^3$ per capita per annum. They stated that the high consumption is influenced by easy availability of free fuelwood. However, they recommended strongly that a severe fuelwood shortage will be experienced by Tanzania in the near future due to the intensive clearing of forests currently taking place without regeneration.

2.2.2 Consumption and availability

The main factors determining the level of consumption of fuelwood in rural areas in most developing countries are the physical availability of the fuelwood and the amount of time which must be spent collecting the fuelwood. Table 2.2 indicates in a generalised broad spectrum, estimated consumption of fuelwood in different continents. Consumption is high where wood resources are still abundant and conveniently distributed relative to population, for example in southeast Asia and East Africa.

In Nepal it has been observed (Earl 1975) that migrants from the wood-poor hills to the forested Terai region of that country have been found to use twice as much fuelwood as their companions remaining in the hills. In Thailand the household use of fuelwood in the wood-poor central region is less than half that used in the rest of the country (Arnold and Jongma 1978). In the plateau area of northern Tanzania, the difference in household use of fuelwood between villages in wooded areas and villages with little or no surrounding woodlands is estimated to be more than three-fold (Openshaw 1971).

A survey carried out in India (Arnold and Jongma 1978) revealed that villagers located near the forest boundaries collected about 70 percent of their fuelwood from the forest. But as the distance of the village from the forest increased beyond 10 km the proportion of fuelwood collected from the forest diminished sharply. At 15 km the amount collected was negligible. The fuelwood was collected manually.

In the savanna regions of Nigeria fuelwood is transported by road for distances of up to 100 km, but a more usual limit to the supply distance is less than 50 km (Openshaw 1978). Earl (1975) stated that in Uganda the point of indifference between the cost of producing and transporting fuelwood or charcoal on an equivalent thermal content basis is 82 km. At distances below 82 km it is economical to transport fuelwood while at distances above 82 km it is economical to convert the fuelwood to charcoal and to transport it as charcoal due to its higher calorific value per unit weight. However, the limiting lower and upper economic distance constraints which may be applicable to any country will depend on the country's transportation system and freight charges (Earl 1975). To find the haulage distance at which charcoal manufacture for normal heating purposes becomes worthwhile, it is necessary to know the costs of production, the distance between forest and market and the costs per tonne kilometre (Figure 2.1 modified from Earl (1975)). In general, transport costs in most developing countries are high and unreliable and so all possible effort should be made to provide fuelwood close to the consumers, especially to villagers who collect their fuelwood manually.

Table 2.2

Estimated consumption of fuelwood for different continents

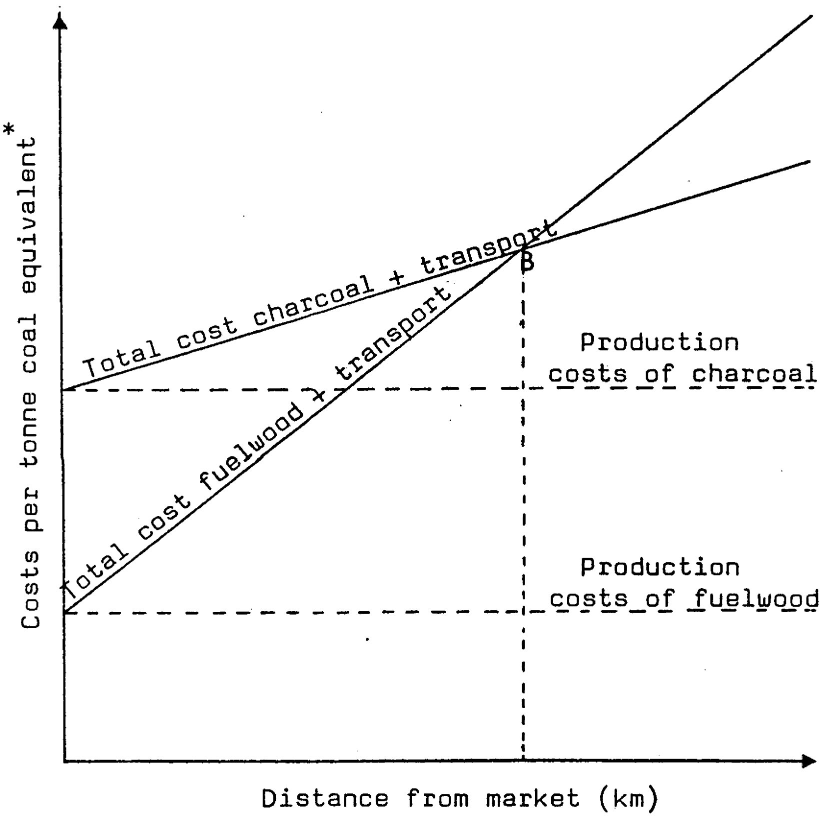
Continent	Annual consumption of fuelwood	
	Total million m^3	per capita m^3
Asia and Pacific		
Southeast Asia and Pacific	278	0.91
South Asia	267	0.38
China and other Asia	148	0.18
Near East	13	0.15
Africa		
North Africa	55	0.50
West Africa	110	0.92
East Africa	117	1.14
Latin America		
Central America	33	0.36
South America	199	1.03

Source: Arnold and Jongma 1978

Figure 2.1

Determination of economic break-even point between charcoal and fuelwood production + transport costs

B is the break-even point.



*It is assumed that 2.3 tonnes of fuelwood is equivalent to one tonne of coal. It is also assumed that $1m^3$ of air dry fuelwood is equivalent to one tonne of fuelwood by weight.

2.2.3 Consumption and income

Fuelwood consumption in developing countries appears to be income inelastic (Openshaw 1978). An analysis of national per capita averages in 1971 indicated a slight negative correlation between fuelwood consumption and annual income growth in Asia, but no discernible correlation in Africa and Latin America. Evidence from within specific countries is similar. In Thailand, average household consumption of fuelwood in four of the five different income groups was approximately the same, while in the highest income groups it was a little lower. In Tanzania there was no significant difference in average per capita consumption in the low income groups covering more than 90 percent of the rural population, whereas a difference of about 10 percent was observed for the high income group. In urban areas in Tanzania, the correlation between fuelwood consumption and income was slightly more pronounced, as most of the fuelwood in urban areas is a commercial commodity and not obtained free as in most rural areas. The high income group have more to cook and higher purchasing power, hence higher consumption as compared to the low income group.

Fuelwood scarcity has led to a rise in fuelwood prices in urban areas consequently creating a heavy economic burden on the low income people. In many urban areas in Tanzania low income people are spending a minimum of 30 percent of their income on the purchase of charcoal and fuelwood for domestic purposes (Kaale 1979a). The price of a bag of charcoal has increased from US $2 in 1970 to US $15 in 1979. The increase in price is mainly due to increased transport costs of charcoal and fuelwood, now being collected from further and further away each month, and each year.

In Niamey, Niger, the average low income family spends over 25 percent of income on fuelwood. In Ouagadougou, Upper Volta, the portion is more than 30 percent. Those who cannot pay the price are forced to cook less. Sometimes they are inclined to scrounge about the town for twigs, garbage or anything burnable. In some towns in Pakistan people strip bark off the trees that line the streets in order to meet their undeniable fuelwood needs (Arnold and Jongma 1978). In Colombia it is estimated that about 20 percent of annual income is spent on the purchase of fuelwood for domestic use (Cecelski et al 1979).

Observations carried out in Mexico City, Bombay, Delhi, Calcutta and in some towns of Pakistan revealed that domestic energy consumption rises much less than income (Cecelski et al 1979). The quantity of fuelwood consumed by the poor is frequently described as 'inelastic' in the sense that, regardless of income level, it is a basic necessity for survival. In urban areas where other forms of commercial energies are available, ie. electricity and bottled gas, rising incomes lead to the use of the more efficient energy source among those available so long as differences in cost are not significantly high. High incomes permit the purchase of expensive stoves which are required for energy sources other than fuelwood. Low income people are unable to purchase such stoves even if fuelwood is not the most efficient source of energy available to them.

2.3 Problems caused by the requirement for fuelwood exceeding supply

Problems created because fuelwood requirement exceeds supply in developing countries include deforestation, social conflict, waste of productive labour, use of animal dung and farm residues as fuel and finally, desertification. These are a few of the more significant internal factors hindering rapid socio-economic development in many developing countries.

2.3.1 Deforestation

Deforestation is one of the main problems caused by fuelwood requirements exceeding supply. FAO (1978) estimated that the existing area of forest in developing countries is being reduced annually by 5-10 million hectares in Latin America, 2 million hectares in Africa and 4 million hectares in Asia. Deforestation in developing countries, along with fossil fuel consumption by the rich countries, are contributing significantly to the increase of CO_2 concentration in the earth's atmosphere (Gifford 1979).

Deforestation is severe in the neighbourhood of rural areas with large population densities which require large amounts of fuelwood daily (Arnold and Jongma 1978). The intense pressures on small land areas for fuelwood lead to complete removal of all trees and shrubs cover on the area. The use of 3 million cubic metres of fuelwood in Bangkok is reported to be felt over a large part of Thailand. Even in the Sahel, a sparsely populated region, areas surrounding small and medium centres of population are largely deforested. In a fishing centre in the Sahel, where more than 40,000 metric tonnes of fish is dried annually using fuelwood, deforestation extends for more than 100 km away from the centre.

Observations carried out in Africa by Howe and Gulick (1980) indicated that the rate of consumption of fuelwood already exceeds the annual rate of replenishment as the population is increasing, so the requirement for fuelwood is growing. Shortage of fuelwood is leading to total destruction of forests in many developing countries. They indicated that Senegal will be bare of trees in 30 years, Ethiopia in 20 years and Burundi in 7 years if the present rates of deforestation is not stopped. Much of the eight nation region of the Sahel will become desert by the year 2000 unless massive reforestation and fuelwood planting is undertaken soon.

A survey carried out by the World Bank in nine African countries revealed the present annual rates of afforestation would need to be increased by from 8 to 50 times to meet domestic fuelwood needs by the year 2000 (Howe and Gulick 1980). This applied even if 30 to 50 percent of the total energy requirements in rural areas could be met by forms of energy other than wood, eg. hydro-electricity, or through increased efficiency in end use. Estimates of tree planting targets needed to meet domestic fuelwood requirements to the year 2000 for some African countries are listed in Table 2.3. In general, developing countries have to intensify the establishment of fuelwood plantations if future fuelwood requirements are to be met.

Table 2.3

Comparison of current annual afforestation programs for some African countries with approximate planting targets needed to meet domestic fuelwood requirements to the year 2000

Country	Current annual afforestation program (000's of ha)	Approximate annual program needed to meet domestic fuelwood requirements to the year 2000 (000's of ha)*	Total planting target needed by the year 2000 to meet domestic requirements (000's of ha)	Factor indicating by how much the present annual rate of planting would have to be increased to meet domestic requirements to the year 2000
Rwanda	1.5	13.0	260	8.6
Burundi	1.5	5.4	110	3.6
Malawi	2.5	13.0	260	5.2
Tanzania	2.5	20.0	400	8.0
Sierra Leone	0.5	2.5	50	5.0
Niger	0.5	3.5	70	7.0
Mali	0.5	4.0	80	8.0
Nigeria	10.0	100.0	2,000	10.0
Ethiopia	1.0	50.0	1,000	50.0

Source: Howe and Gulick 1980

* Based on the assumption that between 30 to 50 percent of the total rural energy requirements could be met by forms of energy other than wood, such as hydro-electric power, and by greater end use efficiency of fuelwood.

Fuelwood consumption in many developing countries is not confined to domestic use only. In some countries like Tanzania fuelwood requirement for non-domestic purposes, like tobacco curing and brick burning, is causing significant deforestation. To elucidate the issue the fuelwood requirement for tobacco curing in Tanzania is discussed briefly.

In Tanzania tobacco farms are created by clearing forests and for every one hectare cultivated, an additional one hectare of forest is cleared for the provision of fuelwood for curing the tobacco. Temu (1979) stated that fuelwood is an essential raw material for producing flue-cured tobacco in the Tabora region, which produces about 60 percent of the tobacco produced in Tanzania for export. Due to root-knot nematodes (Meloidogyne spp) infection, tobacco farmers in Tabora practice shifting cultivation and they can cultivate one plot consecutively for a period of three years only. Intensive cultivation of tobacco started in Tabora region in 1969, and by the end of 1979 more than 103,700 hectares of forest had been cleared for tobacco cultivation (Table 2.4). However, within this period (1969-1979) only a total of 500 hectares of fuelwood plantation were established. The author stated that the search for alternative source of energy for tobacco curing in Tabora revealed that fuelwood is the only reliable and economical source of energy. Future supply of fuelwood for tobacco curing will only be attained if intensive establishment of fuelwood plantations is incorporated with tobacco cultivation.

Deforestation is serious in all tobacco growing regions in Tanzania, mainly in Tabora, Iringa, Ruvuma, Rukwa and Mbeya (Mnzava 1980). He quoted an example of Ulowa village in Kahama district which is expanding its tobacco program by clearing 750 hectares of forest land each year, but it does not have a village afforestation scheme. The concentration of people in Ujamaa villages has created intensive pressure on fuelwood requirement to forests adjacent to the villages (Brown 1977, Mnzava 1980). Deforestation is pronounced in the vicinities of most villages in Tanzania. Forest reserves close to villages facing fuelwood shortages are currently poached heavily.

Deforestation in the steep hills of Nepal has caused a fuelwood crisis in the country in addition to land-slides and serious soil erosion caused by water which is destroying both farms and roads. Also the capability of the land to support the increasing population is declining rapidly (Earl 1975).

Table 2.4

Tabora region tobacco production data

Season	No. of families growing tobacco	Area under tobacco (hectares)	Estimate of fuelwood used $1000m^3$ stacked	Actual cured and marketed tobacco (1000 kg)
1969/70	6,071	5,538	582.7	2,903.7
1970/71	6,154	6,819	715.0	4,911.1
1971/72	10,944	6,446	676.8	5,215.2
1972/73	11,738	5,328	559.4	6,801.5
1973/74	13,629	10,300	1,081.5	9,951.4
1974/75	21,308	11,930	1,252.7	7,210.9
1975/76	20,483	11,110	1,166.6	8,582.1
1976/77	27,480	14,319	1,503.5	8,937.2
1977/78	26,879	15,902	1,669.7	9,200.0
1978/79	27,000	16,000	1,770.0	*

Source: Temu 1979

* Data not available.

2.3.2 Social conflicts

Substantial social conflict between foresters and villagers can occur in villages in the vicinity of forest plantations that face fuelwood shortages. Soedarwono (1979) stated that in Indonesia, protection of *Tectona grandis* plantations surrounding villages facing fuelwood scarcity was impossible. Illegal felling of trees in the plantations was very common, to the extent of forcing the Indonesian forest division to clearfell stands prematurely before such stands were felled illegally by villagers. The problem was solved by the Indonesian forest division by co-operating with the villagers and by providing them with fuelwood.

In India, villagers would settle in the vicinity of plantations to be clearfelled due to availability of employment in logging operations (Banerjee 1979). However, once the logging operation was completed, the villagers became jobless and started to fell trees illegally from the forest for sale in order to earn a living. As in the Indonesian situation the problem was solved by co-operating with the villagers and by providing them with employment or by educating them as to how they could solve their socio-economic problems more appropriately.

Shortages of fuelwood have encouraged people to collect fuelwood illegally from protected forest reserves in many developing countries (Arnold and Jongma 1978). In India, mobile guard squads and mobile courts have been established to capture poachers in national forests and punish them severely. This has not succeeded, as law enforcement measures have little effect in such an untenable situation. Severe shortage of fuelwood has undermined administrative control even in China, where trees on commune plantations are sometimes surreptitiously uprooted for fuelwood almost as soon as they are planted.

2.3.3 Waste of productive labour

Where fuelwood could be collected in the immediate vicinity of most households a few years ago, it now has to be gathered and carried from distances up to a full day's walk. As fuelwood becomes more scarce more rural labour will be diverted to the collection of fuelwood. Even in conditions of usually widespread rural unemployment, fuelwood gathering becomes a significant constraint on other activities in those seasons of the year when agricultural labour is in high demand. For example, in central parts of Tanzania, more than 300 mandays per annum per family are used for collecting fuelwood (Mnzava 1980). In some parts of the Arusha region of Tanzania, more than 400 mandays per annum per family are used for collecting fuelwood (Kaale 1979a). In Lushoto Tanga (Tanzania), women who are solely responsible for fuelwood collection worked an average of 64 hours per week during daylight hours (Fleurent and Fleurent 1978). Among these, cooking and housework accounted for an average of 27 hours per week. If food preparation and fuelwood collection could be simplified, labour input into the critical area of subsistence production could be much larger. Fuelwood collection is one of the most arduous tasks performed by Tanzanian women. They have to carry heavy loads of fuelwood (about 33 kilograms) for distances up to 10 km. Female children begin to help their mothers in fuelwood collection almost as soon as they can walk, and it is not unusual to see three or four year old girls walking home with large bundles of twigs on their heads.

It has been estimated that if the time spent by villagers of Machakos Kenya on collecting, cutting and carrying fuelwood collected freely from the nearby forests to their homes were costed at current daily labour rates, it would be cheaper to use other forms of energy like kerosine or electricity if they were available (Openshaw 1980a).

Thus it can be seen that much effort is required to collect fuelwood in many developing countries and the situation is getting worse. If alternative sources of fuelwood or other energy sources were available the people could divert their energy and time to other forms of productive activity.

2.3.4 Burning of animal dung and farm residues

Animal dung and farm residues are used as substitutes to fuelwood where fuelwood cannot be obtained. Use of these materials as fuelwood deprives the soil of nutrients which leads to the reduction of agricultural production. The diversion of animal dung and farm residues to fuel thus becomes the equivalent of burning food to cook food. Arnold and Jongma (1978) estimated that each tonne of animal dung burnt may mean a loss of production of 50 kg of food grain or more.

Serious food shortages will be experienced in many developing countries if animal dung and farm residues continue to be used as fuel instead of being used as manure on the farms. Eckholm (1975) stated that in India, plant nutrients wasted annually due to the use of animal dung as fuel is reported to be more than 40 percent of the country's chemical fertiliser use. The author also stated that fuelwood scarcity in Eastern Nigeria forced the rural people to uproot crop residues after the harvest for use as fuel. Before the scarcity, the dead stalks and leaves were left to enrich the soil and to reduce soil erosion.

Shortage of fuelwood is not only inducing villagers to use animal dung and farm residues as fuel, but it is also affecting nutritional well-being of people in parts of West Africa where cooked meals have been reduced to one a day. Also in the Uplands of Nepal where only vegetables which can be eaten raw are normally grown. Introduction of new food crops with better nutritive value into the wood-poor hills of Haiti failed mainly due to shortage of fuelwood to cook such foods (FAO 1978).

2.4 Desertification

Desertification was defined by the United Nations (1977) as the extension or intensification of desert conditions involving a decline in the productivity of the land. Deserts are areas with extremely limited agricultural potential. They occur in a variety of types, hot and cold, stony and sandy, but all are characterised by rainfall deficiencies so marked that cultivation or stock rearing are possible only with special adaptations, for example through irrigation schemes.

Desertification does not necessarily mean expansion of existing deserts since the process does not spring from the desert cores; it need not always work outward. Semi-arid or subhumid croplands may deteriorate to desert status due to overgrazing, deforestation and poor farming practices accompanied by soil erosion caused both by wind and water. Many marginal lands of the arid world that otherwise could be serving needs of some people are now essentially wastelands as the result of over-exploitation. The destruction of woody species as fuelwood, and for other domestic purposes, is one aspect of desertification.

Social and economic disasters always accompany desertification. Desertification anywhere can affect the whole global community due to the decline in agricultural production, accompanied by high death rates of people due to starvation, as experienced in the Sahel drought of 1968 to 1973 when about 250,000 people died (United Nations 1977). Developing countries experiencing desertification are severely affected both economically and socially due to lack of foreign currency to import food relief from outside. In developing countries, desertification worsens existing conditions of poverty, brings malnutrition and thus susceptibility to disease, erodes the basis of the national economy and then strains social services already hampered by remoteness and lack of funds.

Lands beyond those immediately affected by desertification can suffer damage as dust storms can move soil great distances, and increased flooding may occur far downstream due to rapid runoff from lands denuded of trees and plants. It has been estimated that the lives of over 700 million people in developing countries are currently at high risk if immediate action is not taken to stop desertification. The annual world rate of land degradation due to desertification is estimated to be above 6 million hectares. Costs of rehabilitating degraded land are estimated to be high, about US $2,000 per hectare (United Nations 1977). Many developing countries do not have the capital and resources to rehabilitate large areas of degraded land. The effects of desertification on man appear most dramatically in the mass exodus that accompanies drought crises and the massive destruction of livestock. Some human diseases are specific to desert areas, such as eye disease (trachoma) and bilharzia.

Desertification arises from the interaction between a difficult, unreliable and sensitive dryland environment and man's use and occupation of it in his efforts to make a living (United Nations 1977). The vulnerability to desertification and the severity of its impact are partly governed by climate in that the lower and more uncertain the rainfall, the greater the potential for desertification. FAO (1976) stated that desertification is perhaps the most important hazard that is threatening the low rainfall areas of the world.

Dry lands which are vulnerable to desertification are classified by the United Nations (1977) as those areas with mean annual rainfall below 800mm. These areas consist of the arid lands (rainfall below 250mm) with not enough rain to support cropping but with sufficient vegetation to support pastoralism. Outside the arid zone are the semi-arid lands with rainfall between 250mm to 600mm, where, depending on temperature and season, cultivation of drought resistant crops is generally possible. Finally the greener margins of the dryland belts comprise the drier parts of the subhumid zone with rainfall between 600mm to 800mm. Population density in the subhumid zone is normally high accompanied by intensive land use pressure which leads to desertification.

Prevention of desertification can be achieved through proper land use planning and through educating the people of the bad effects of desertification and the means by which they can prevent it. United Nations (1977) argue that since desertification is a human problem, measures to combat it must ultimately be directed toward people, towards sustaining and improving their economic and social conditions. Once they conceive the worthwhileness of preventing desertification, then on their own willingness they may co-operate with government agencies in the endeavour to prevent desertification.

In Tanzania, nearly the whole country is currently exposed to desertification. About 90 percent of the country receives a rainfall below 800mm. Overgrazing and deforestation accompanied by severe soil erosion is taking place all over the country and with the current population growth of 3.4 percent per annum, desertification in Tanzania can be expected to increase. Large parts of the country have already been turned to desert conditions, Kondoa being a good example where over 150,000 hectares of land have been completely turned to wasteland.

As the economy of Tanzania depends highly on the agricultural sector, unless immediate and effective measures are taken to prevent this increasing rate of desertification, severe economic and social stress will be experienced in the near future. Village afforestation is expected to minimise desertification, but the problem will only be solved by the combined effort of all land users.

2.5 Energy and economic efficiency of fuelwood

Fuels like electricity, coal and gas require high capital investment in stoves before they can be used. Many low income people are unable to purchase such stoves even if the relative prices of these fuels would later allow lower operating costs. For example, in Tanzania the cheapest one burner table electric cooker costs US \$240 and the cheapest gas cooker costs about US \$360 (the national annual income per capita is US \$150). In most developing countries, most of the alternative fuels, as well as the stoves to be used with such fuels, are imported and foreign currency is scarce. Under these conditions people continue to rely upon fuelwood as their main source of domestic energy. Although Earl (1975) has shown that fuelwood is relatively energy inefficient due to its high ratio of weight to calorific output as compared to other fuels (Table 2.5) it is more economically efficient in Tanzania, than alternative commercial fuels.

Table 2.5

Calorific value of different fuels

Type of Fuel	mJ per kilogram
Paraffin (kerosine)	43.6
Fuel oil	41.1
Charcoal	29.7
Coal	28.9
Wood (oven dry)	19.7
Wood (air dry)	14.7
Cow dung (dry)	16.7
Peat (dry)	16.7

Source: Shepherd 1979

Energy conversion factors:			
	Cal (calorie)	=	4.19J (joules)
	Kcal (kilocalorie)	=	4.19kJ (kilojoules)
	1000 Kcal	=	4.19mJ (megajoules)

2.6 Conversion of fuelwood to charcoal

The simplest method of upgrading the value of wood as fuel is to convert it to charcoal. In most developing countries charcoal is produced mainly by using simple kilns. These may be simple earth kilns, portable steel kilns or brick kilns. More advanced methods of making charcoal are available, such as retorts, continuous combustion kilns and furnaces which give higher production and recovery percent. The advantages and disadvantages of the different methods of converting fuelwood to charcoal are summarised in Table 2.6. The table indicates clearly the suitability of simple kilns for developing countries in contrast to retorts, continuous combustion kilns and furnaces.

Conversion of fuelwood to charcoal is not an efficient method of using fuelwood, especially in areas with fuelwood scarcity, because of heat losses in the process of manufacturing charcoal. More wood raw material is used when charcoal is burned than if the wood had been burnt directly as fuelwood. Openshaw (1978) stated that in earth kilns, common in developing countries, an average of 12 metric tonnes ($12m^3$) of roundwood are required to produce 1 tonne of charcoal. The energy recoverable from converting charcoal in earth kilns is thus about 25 percent of that in the original wood. Table 2.7 shows conversion factors from roundwood to one tonne of charcoal in a few African countries.

Table 2.6

Advantages and disadvantages of different methods of converting fuelwood to charcoal

Advantages	Disadvantages
Kilns - Low capital cost - No external fuel requirement - Low technological requirement - Labour intensive - Relatively large pieces of wood may be used - Moisture content not critical - Can be made with local materials	- Difficult to control the quality and quantity of charcoal - Not possible to collect by-products - Very small materials, eg. chips, sawdust and bark cannot easily be utilised
Retorts - High yield of charcoal - Possible to collect by-products - Possible to control quality of charcoal	- Capital intensive - Normally require imported materials - Require advanced technology - Size and moisture content of wood has to be strictly controlled - Require external energy source for at least part of the process - Not portable
Continuous kilns - Can utilise small sized residues - Cheaper than retorts and furnaces - Provide continuous supplies of good quality charcoal	- Charcoal is hot when discharged and therefore requires special handling - By-products cannot be collected - Require external energy input for at least part of the time - Not portable
Furnaces - Can utilise any organic materials including woodchips, sawdust and bark - Provide continuous supplies of high quality charcoal of any desired volatile content	- Not labour intensive - Capital intensive - Wood has to be chipped - Moisture content must be below 45% - Not portable - Require advanced technology - By-products cannot be collected - Require imported materials

Source: Earl 1975

Table 2.7

Conversion factors, roundwood to one tonne of charcoal

Method of charcoal production	Tonnes of roundwood used to produce 1 tonne of charcoal *	Country from which the observation was conducted
Steel portable kilns	6	General in many countries
Brick kilns	6	General in many countries
Earth kiln	12	Sudan
Earth kiln	24	Nigeria
Earth kiln	12	Zambia
Earth kiln	12	Tanzania

Source: Openshaw 1978

* It is assumed that $1m^3$ of roundwood is equivalent to one metric tonne.

The high figure of 24 tonnes of roundwood to one tonne of charcoal in Nigeria needs further investigation, however, the 12 tonnes of roundwood to one tonne of charcoal is a reasonable figure which can be used for estimating amount of wood required for charcoal production by using earth kilns.

Production of charcoal can be doubled if portable steel kilns or brick kilns are used instead of earth kilns. This will minimise significantly the amount of roundwood required for production of charcoal and make charcoal production more economical and less destructive to the ecological system.

In spite of the loss of potential heat energy in the conversion of wood to charcoal, there are circumstances where this conversion will be desirable:

(a) Charcoal has a higher calorific value per unit weight than fuelwood (Table 2.5). It is more economical to transport charcoal over longer distances compared to fuelwood. However, it is easily crushed to charcoal dust if not handled properly in storage and transportation. Where an excess of wood is available in areas remote from population centres, then it will be feasible to transport the energy as charcoal. Where land clearing is taking place and the forest is being burnt it makes good sense to convert the wood to charcoal so that it is not lost.

(b) Storage of charcoal takes less room as compared to fuelwood and it can be stored in containers which can be handled for transport and sale more easily.

(c) Charcoal is not liable to deterioration by insects and fungi.

(d) Charcoal is smokeless and almost sulphur-free, as such it is an ideal fuel for towns and cities. It can be used in stoves capable of heating the house and providing hot water as well as being adapted for general cooking purposes. However, as with all fuels with a high carbon content, care has to be taken during combustion to ensure that there is free circulation of air because of the danger of carbon monoxide poisoning.

2.7 Efficient use of fuelwood

Studies carried out in many developing countries indicate that fuelwood is often used inefficiently and that the present fuelwood consumption could be reduced by more than 50 percent if efficient methods of using fuelwood were adopted. Cecelski *et al* (1979) estimated the efficiency of open fire cooking to be about 10 percent only. Openshaw (1980b) estimated the efficiency of most traditional African kitchen fireplaces, which consist of three stones on which the cooking pot is placed (Figure 2.2), to be about 7 to 8 percent only.

Openshaw (1980b) stated that of the household fuelwood requirements, about 55 percent by volume is used for cooking, 20 percent for warming water, 15 percent for heating and the remaining 10 percent for ironing and for protection purposes. As 75 percent of the fuel is used in stoves for cooking and warming water, energy saving efforts should be concentrated in the development of more efficient cooking stoves. If the efficiency of current stoves could be improved from 8 percent to at least 20 percent the present fuelwood shortage in many developing countries will be minimised significantly. Costs of introducing more efficient stoves are extremely low and are insignificant when compared to the savings of fuelwood to be achieved. Development of more efficient cooking stoves is therefore one among the vital aspects to be considered in the endeavour to solve the fuelwood scarcity.

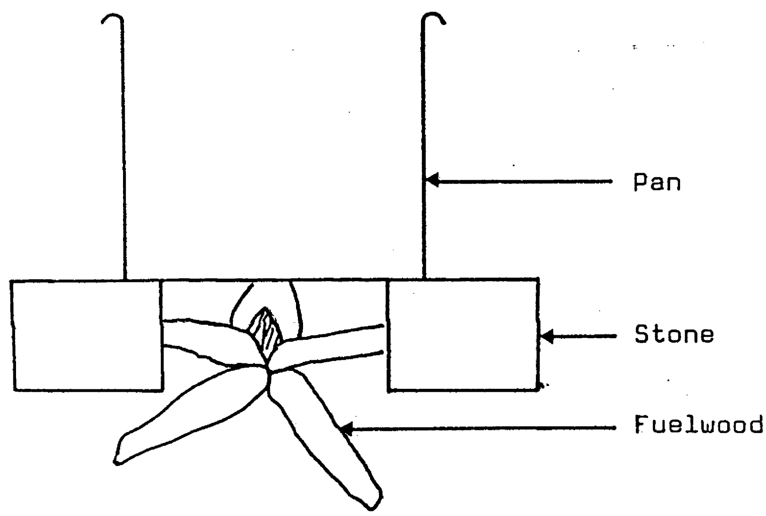
The traditional open cooking fire (Figure 2.2) is extremely inefficient due to the fact that much heat is radiated outwards as well as upwards and the flame is not concentrated to the cooking pot. Nearly all rural people in Africa are still using the open fire cooking system. Another disadvantage of the open fire system is that there is no chimney to take away the smoke, so that the person cooking has to contend with smoke.

A relatively simple closed fuelwood stove with an efficiency of 15 percent has been developed by the Division of Forestry, University of Dar es salaam, Tanzania (Figure 2.3). The stove is simple in design so that it can be constructed easily by villagers using available local materials such as mud or burnt bricks and with minimum cost. The stove has a chimney to carry the smoke away, it is raised off the ground for comfort and it is easy to clean and maintain. Openshaw (1980b) stated that if the new design of fuelwood stove were universally adopted in Tanzania, fuelwood consumption would be reduced to as little as 50 percent of the present consumption.

Figure 2.2

Typical rural African open fire place

Cross section



Plan elevation

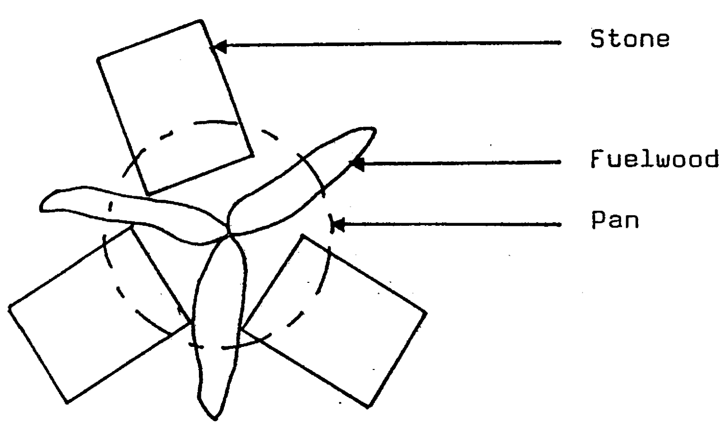
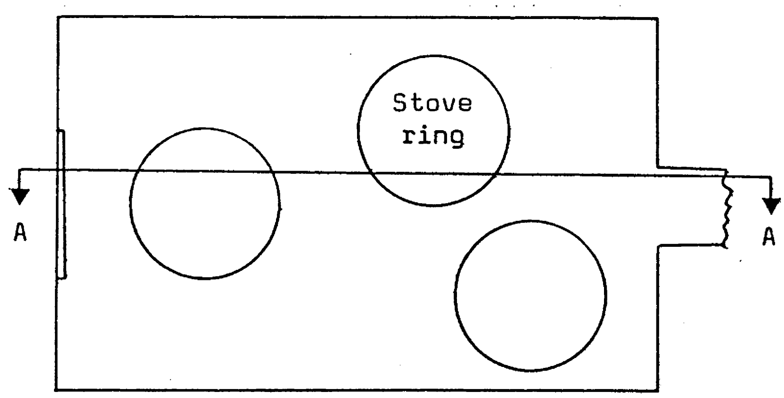


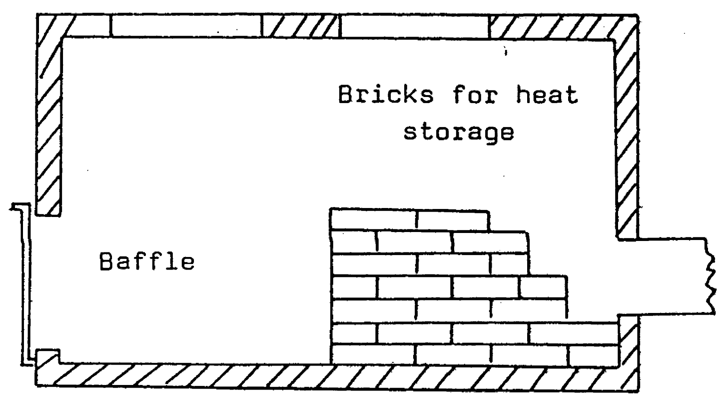
Figure 2.3

Design of improved fuelwood stove

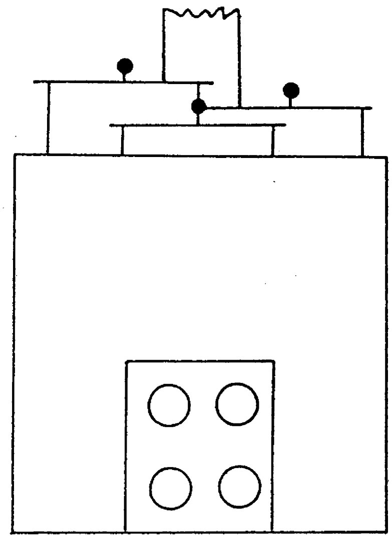
Plan elevation



Section A-A



Side elevation



At least 40 percent of charcoal could be saved by the individual householder if metal stoves commonly used in Africa were substituted with clay stoves, and cooking time could be reduced by more than 35 percent if the switch was made (Openshaw 1979b). Metal stoves radiate much heat both outwards as well as upwards, hence are inefficient; clay stoves are better insulated. In his experiments to compare the efficiency of the two stoves, Openshaw (1979b) found that by using the same quantity and quality of charcoal, on average twice as much water was boiled in the clay stove as compared with the metal stove. The average time spent to boil water on the clay stove was 40 percent less than on the time spent on the metal stove. The price of a clay stove is lower than the metal stove which costs, on average, US $5 in Tanzania. The metal stove requires imported inputs, but the clay stove is made purely with local materials.

In summary the advantages of the clay stoves are:

(a) They can be built by anyone without special tools and even without training once demonstration stoves are available.
(b) They use less fuelwood than metal stoves.
(c) They can do all types of cooking.
(d) They use locally available materials which are free in most country areas.
(e) Cooking time can be reduced by up to 40 percent.
(f) Smoke is controlled.
(g) They are raised off the ground hence more comfortable to use.

Shepherd (1979) recommended strongly that governments of developing countries should put great emphasis on the development of more efficient fuelwood and charcoal stoves in order to minimise current fuelwood consumption. Developed efficient stoves should be constructed from readily available local materials, easy to construct and easy to use with existing utensils owned by villagers.

Efficient fuelwood and charcoal stove demonstration centres should be established in all villages so that villagers can see them physically and copy the technology by developing or constructing their own stoves. The tremendous saving in fuelwood and cooking time will definitely attract people's interest.

The most important controllable factor influencing the efficiency of wood as fuel is the moisture content (Earl 1975). Moisture in very fresh wood may amount to more than 100 percent of the dry weight. This reduces its value as fuel because of the heat loss involved in the evaporation of water. Reduction of the moisture content in wood to be used as fuelwood is desirable in order to reduce handling and transport costs and to increase the calorific heat value of the wood. Table 2.8 contains some figures on proportions of heat lost by using wood with different moisture contents. Temu (1979) emphasised that people should be encouraged and educated on the importance of using dry wood in order to minimise their fuelwood consumption. In general, villagers use dry fuelwood in Tanzania but, as fuelwood becomes more scarce, they tend to use more greenwood hence increasing consumption.

Table 2.8

Effect of moisture content on the calorific value of wood

Moisture content ovendry basis (percent)	Heat lost, based on that available at 10% moisture content (percent) *
20	10
50	32
100	54
200	76

Source: Panshin <u>et al</u> 1962

* Heat is lost as latent heat of vaporisation of water from the wood.

CHAPTER 3

RENEWABLE ENERGY SOURCES OTHER THAN FUELWOOD WHICH CAN CONTRIBUTE TO DOMESTIC ENERGY DEMAND IN DEVELOPING COUNTRIES

3.1 Introduction

Renewable energies, like hydro-electricity, biogas, solar energy and windmills, can contribute to domestic energy demands in the future, so that when forecasting future demand of fuelwood in developing countries, the possible contribution of these energy sources should not be neglected. The present pressure put on forest lands will be minimised if alternative energies for domestic use are available to villagers. The shift from wood burning stoves to those running on natural-gas, coal and electricity observed in many developed countries in the twentieth century, can also be expected to take place in some of the developing countries where such energy sources are available. In 1850 fuelwood made up 91 percent of the total domestic energy used in the United States of America, but in 1975 fuelwood used for domestic purposes was insignificant when compared with other sources of energy (Eckholm 1975). However, the alternative energies require high technology and high initial capital investment, both scarce in most developing countries. On these grounds, fuelwood will continue to be the main source of domestic energy. As the alternatives to fuelwood are not expected to contribute significantly to domestic energy in the near future, they will be discussed very briefly. The objective of discussing them is to emphasise their existence and that with socio-economic growth they might be of importance in the future.

3.2 Alternative renewable energies to fuelwood

3.2.1 Biogas

Biogas is generated by allowing organic matter of various kinds to decay in low oxygen environments. It is identical to the marsh gas of freshwater wet land. Cecelski et al (1979) stated that any organic waste containing carbon, hydrogen, oxygen and a certain amount of nitrogen may be suitable material for producing biogas. They also stated that biogas is a close substitute to natural gas and can be produced in large quantities and piped economically for short distances. Maintenance costs of biogas plants are reported to be low, but as with natural gas, there is the possibility of safety problems, since methane is explosive when mixed with air in proportions of 5-15 percent by volume.

Residues from biogas plants can be used as fertiliser as the basic components of biogas are compounds of carbon and hydrogen (Mnzava 1980). Most of the nitrogen is retained by the residues. Development of biogas plants has been successful in India, Tanzania and in China. In Tanzania however, low income people are unable to afford the relatively high initial costs of establishing biogas plants which range from US $800 for family use to over US $10,000 for rural communal use. By 1979 there were 29 biogas plants in Tanzania producing biogas for cooking and for lighting but all of them were still under test (Mnzava 1980). As most of the raw materials used for constructing biogas plants are imported in Tanzania, costs of initial establishment are not expected to decline.

3.2.2 Solar energy

Vigorous research is currently being carried out in many developing countries on the use of solar energy as a source of domestic energy. However, the following drawbacks have been attributed to the use of solar energy for cooking purposes in developing countries:

(a) Initial investment costs of establishing solar energy is beyond the economic capacity of most low income people.

(b) The storage of solar energy is very expensive (Howe and Gulick 1980). Solar cooking has to be done in the day time where the sun rays are directed to the cooking utensils, and the cooking must be done outside. This is practicable only for the preparation of lunch. Some solar energy cooking carried out in Tanzania, India, Morocco and Mexico failed to gain users acceptance due to these factors.

Inspite of its drawbacks, solar energy can be used for pre-heating water, which will reduce the amount of other energy required for boiling the pre-heated water (Cecelski et al 1979). They also stated that solar refrigeration of fish could be done successfully in Tanzania.

3.2.3 Hydro-electricity

Many developing countries have a high potential for hydro-electricity generation which is not yet used. For example, Nepal, which is facing a severe shortage of fuelwood, could partly solve its energy problem by using a large untapped hydro-electric potential. The latent power of hydro-electricity in Nepal is estimated to be huge, equalling the hydro-electric capacity of Canada, the United States of America and Mexico combined (Eckholm 1975). However, the huge initial costs of tapping the energy is the main prohibiting factor to Nepal, quite apart from the huge costs for distribution and the relatively sophisticated appliances needed to use the electricity.

Many African countries have abundant resources of hydropower, but very little of it is currently used (Howe and Gulick 1980). According to a United Nations Conference on Trade and Development (UNCTAD) study, less than 2 percent of the potential hydropower in Africa is used. Electrification efforts in many countries are only concentrated in urban areas. Among African countries, only Botswana, Kenya and Tanzania have included rural electrification in their long-range power planning.

Rural electrification will assist significantly in solving rural energy shortages in many regions of Tanzania. For example, in Kilimanjaro region, more than 30 percent of the total population of villages supplied with electricity are currently using electricity for lighting (Kaale 1979a).

3.2.4 Windmills

Windmills are used in many developing countries for pumping water. The use of windmills for generating electricity requires relatively sophisticated machines and expertise for establishment and maintenance, which are far beyond developing countries' capability (Howe and Gulick 1980).

Table 3.1 shows a list of external aid programs related to fuelwood and other renewable energies currently taking place in Tanzania (1980). Hydro-electricity represents the biggest share followed by forestry.

Table 3.1

Current external assistance programs related to fuelwood and other renewable energies in Tanzania (1980)

Donor Country	Type of Project	Estimated Funding 000's US $
Belgium	Hydro-electricity	725
Canada	Hydro-electricity	9,410
Denmark	Solar energy	35
Netherlands	Gas generator fueled by agricultural wastes	870
Netherlands	Windmill projects (Mara region)	10
Norway	Hydro-electricity (feasibility study)	6,000
Sweden	Kidatu hydro-electric project	37,000
Sweden	Forestry, including village afforestation 1976-1982	36,500
Switzerland	Solar and wind studies	20
United Kingdom	Forestry; village afforestation for Tabora, Mtwara and Lindi regions	not stated
International bank for reconstruction and development (IBRD)	Forestry; village afforestation in Mwanza, Shinyangs and Tabora regions	6,200
Australia	Forestry, sponsoring post graduate forestry students	10*

Source: Howe and Gulick 1980

* Australian Development Assistance Bureau, ACT Regional Office, 1981 (personal communication)

CHAPTER 4

CURRENT APPROACHES TO VILLAGE AFFORESTATION IN TANZANIA

4.1 Introduction

Village afforestation was started in Tanzania in 1968 when it was decided to pursue a socialistic policy as a development strategy, where emphasis is put on development for the sake of the majority of the population. Before 1968 the government did not consider the supply of fuelwood and small wood products to villagers, although these products accounted for more than 97 percent of the total wood consumed. Forestry activities were confined to gazetted forest reserves and forest plantations. To incorporate village afforestation into the system, substantial organisational changes were needed in the Tanzania government forest division.

4.2 Amendment of the forest policy

The Tanzania government forest policy was amended in 1968 to incorporate village afforestation for the supply of fuelwood and small wood products to villagers as an objective. The current policy is summarised below.

(a) To demarcate and reserve permanently all land supporting productive forests, or capable of supporting productive forest, which can best be utilised under forestry production, taking into consideration other land uses. To manage these forests efficiently, and ensure a perpetual supply of forest products to the present and future generations with surpluses for export where possible.

(b) To reserve and conserve all water catchment forests and land liable to soil erosion.

(c) To undertake continuous research in all sectors of forestry in order to increase efficiency in managing forest lands and in the utilisation of forest products.

(d) To train enough Tanzanians, both in professional and technical cadres, to manage the forest estates. Also to educate the whole nation on the importance of forests to them and to their descendants and hence their effective role in protecting, conserving and establishing new forests.

(e) To encourage the establishment of small village woodlots in all rural villages for the supply of fuelwood and poles to villagers.

4.3 Increase of forest workers

An acute shortage of trained forest workers for the implementation of village afforestation was experienced in the early years. To overcome the manpower shortage the intake of forestry students enrolled for forestry certificate courses was increased from 20 students in 1968 to 110 students in 1979, the number of diploma students was increased from 8 to 50 and for the forestry first degree course the numbers were increased from 5 to 25. To cater for the increasing number of enrolled forestry students, two forestry institutes were built between 1968 and 1979 including the establishment of the division of forestry at the University of Dar es salaam.

Forestry extension was included as a subject in all forestry courses in order to equip students with a knowledge of how to educate villagers on the importance of forestry to their socio-economic development. Forest extension seminars were conducted for forest workers dealing with village afforestation who had no previous formal training in forest extension.

By the end of 1979 about 1,000 forest workers were engaged in the implementation of village afforestation and a forestry extension section had been established at the forestry headquarter to co-ordinate forestry extension activities in the country. Forestry lessons have been included in the primary and secondary school syllabus. Vocational training for villagers is conducted to show them how to carry out some forest operations on their village fuelwood plantations without the assistance of forest workers.

4.4 Research

Intensive research on fuelwood and pole species with multiple uses was started in 1969 to facilitate the selection of the best species for village afforestation. Previously fuelwood and poles had been regarded as minor forest products and so no emphasis was given to their production. However, fuelwood and poles are now regarded as major forest products as they contribute more than 97 percent of the total products harvested from the forests each year (Table 1.8).

Species with the following silvicultural characteristics are considered appropriate for village afforestation and research is mainly being conducted on such species (FAO 1978, Burley 1980, Mnzava 1980, Mushi 1980).

(a) Ability to survive and remain healthy under given conditions of site and cultural treatment.

(b) Can be managed with minimal skill and supervision on a variety of often difficult sites, when planted in the field.

(c) Resistant to local hazards like drought, fire, browsing and trampling, attack by termites and other pests, soil salinity and poor nutrient status, man-made damage and diseases.

(d) Fast growth characteristics which can produce a high volume of fuelwood per tree and per unit area, also a small amount of good poles in the shortest rotation possible, at least less than 10 years.

(e) Readily available seeds at low cost, preferably from sources that do not involve use of foreign exchange, problems of plant quarantine and loss of viability in transit or storage.

(f) Can be handled easily in the nursery, in the establishment stages and will regenerate with ease for later rotations. Once established, species with strong coppicing ability are of great advantage in village afforestation as they reduce the cost of establishing and tending the second crop. However, it is important to ascertain that yields of coppice crops are not significantly lower than those of the original seedling crop.

(g) Can be easily handled manually, free of thorns and excessive branchiness, also easy to crosscut and split.

(h) High drying rate once cut, natural durability for long storage purpose, it should not spark or smoke, it should not impart unpleasant flavours to food and it should not cause allergenic reactions. These characteristics are very important for fuelwood purposes.

(i) Can stabilise soil and prevent soil erosion.

(j) Soil enrichment capabilities, eg. nitrogen fixing species.

(k) Can provide multiple uses, eg. provision of shade, windbreak shelter, food for humans and animals in leaves, fruits or seeds, poles, light sawn timber in addition to the production of fuelwood.

(l) Species which will not compete with agricultural crops or harbour agricultural pests.

For research purposes, Tanzania is broadly divided into three climatic zones (Figure 4.1): the highlands, the arid zone and the coastal area. The highlands are at an altitude above 1,300 metres with a high rainfall, above 1,000mm per annum, and fertile soils. Arid zones are at medium altitudes, between 300-1,300 metres, have low rainfall, below 800mm per annum, with prolonged dry seasons, sometimes above 6 months. The arid zone is acutely short of fuelwood and experiencing serious soil erosion both by water and wind. Soils in the arid zone are sandy to sandy loams with poor nutrient status. Coastal areas are characterised with low altitudes, below 300 metres, relatively high rainfall, above 800mm per annum and poor sandy soils. Rainfall and temperature data for some meteorological stations within the three climatic zones are illustrated in Figures 4.2 to 4.6.

Tree planting is not a problem in the highlands (Figure 4.2). Climatic conditions in the arid zone are not ideal for intensive tree planting due to prolonged drought (Figures 4.3 and 4.4). Research for village afforestation is currently concentrated within this arid zone. The objective of concentrating research in the arid zone is to identify suitable species which can be used successfully for village afforestation and soil conservation. However, due to the scarcity of fuelwood and the high rate of soil erosion in the arid zone, immediate tree planting based on available information is going on. Species performing well in other areas of the world with similar conditions to those of the arid zones of Tanzania are currently being planted while waiting for local research results.

Figure 4.1

Broad Climatic zones of Tanzania

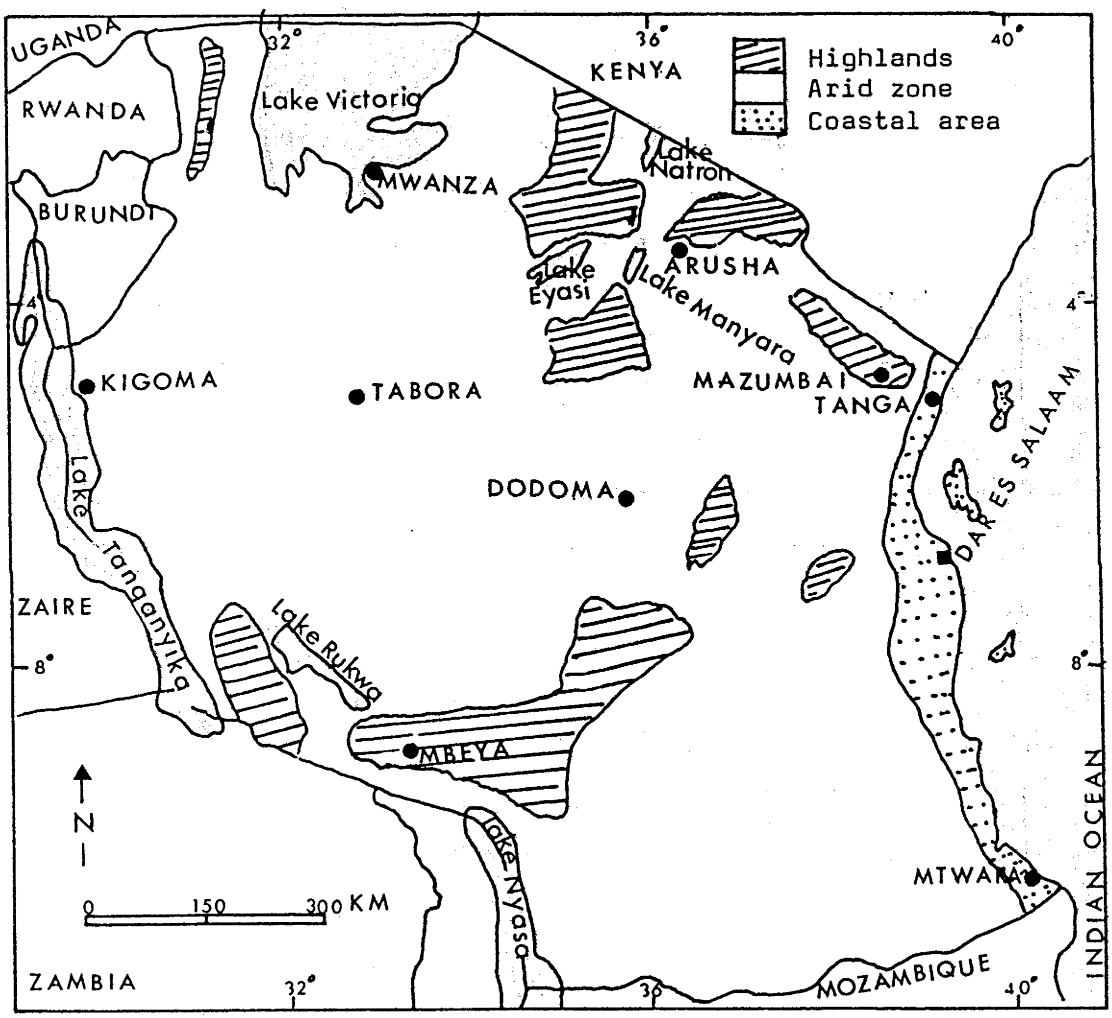


Figure 4.2

Rainfall and temperature data for Mazumbai in the highland zone of Tanzania

Location Lat. $04^{\circ}45'$S   Long. $38^{\circ}29'$E   Elevation 1800m.a.s.l.
(10 years of record)

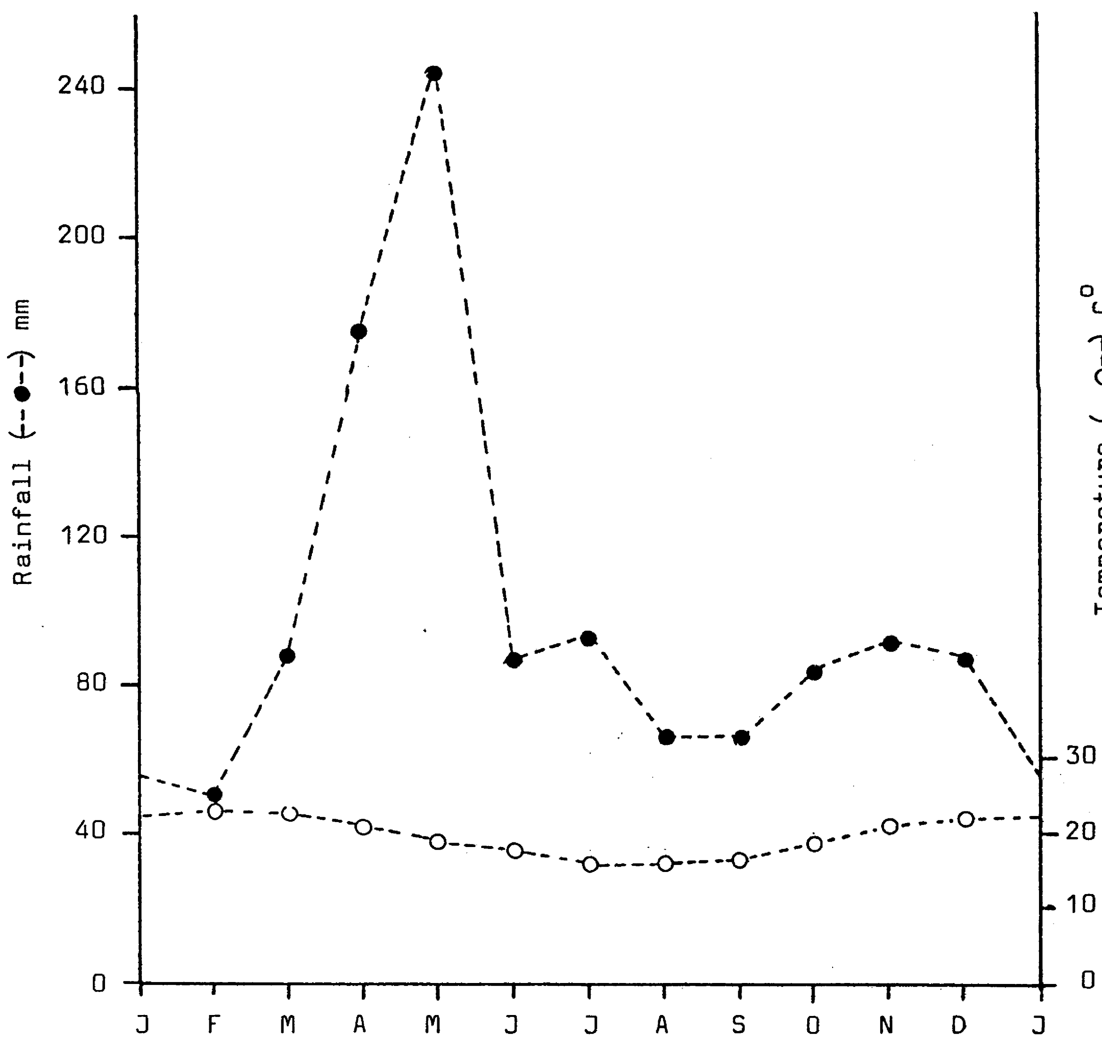


Figure 4.3

Rainfall and temperature data for Dodoma in the arid zone of Tanzania

Location Lat. 06°10'S   Long. 35°46'E   Elevation 1120m.a.s.l.
(10 years of record)

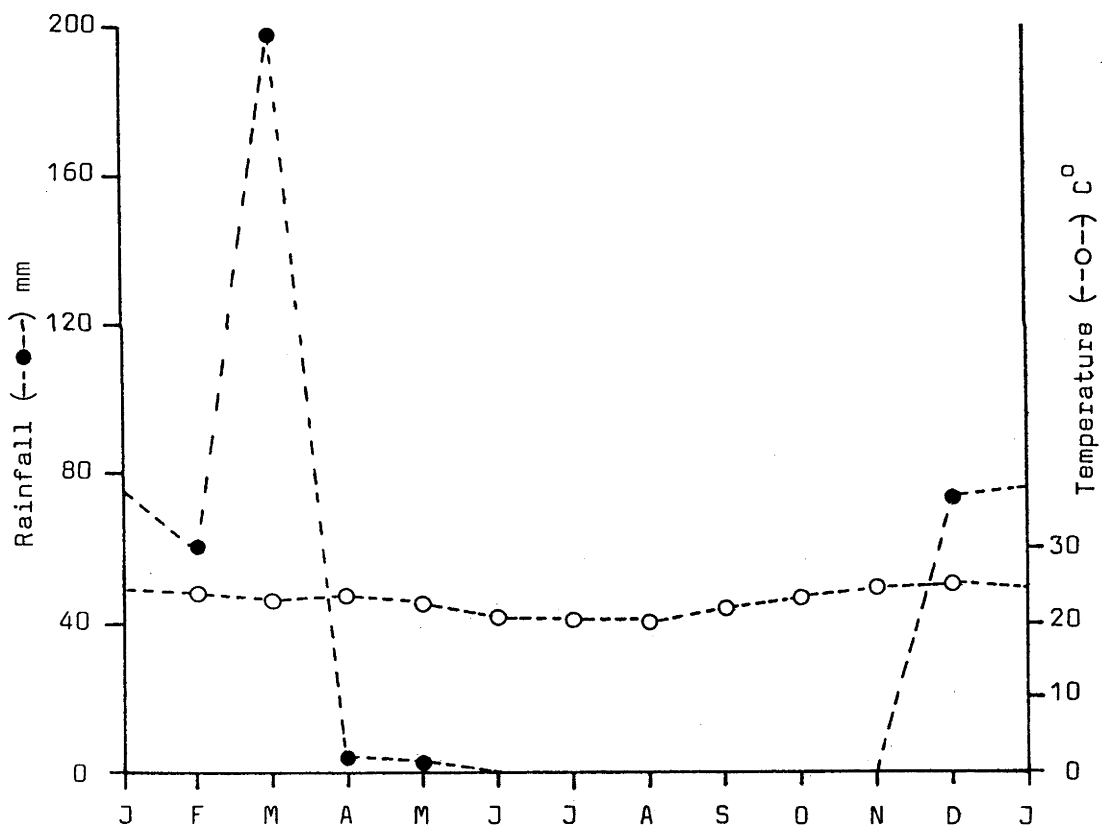


Figure 4.4

Rainfall and temperature data for Tabora in the arid zone of Tanzania

Location Lat. $05^{o}05'S$ Long. $32^{o}50'E$ Elevation 1190m.a.s.l.
(10 years of record)

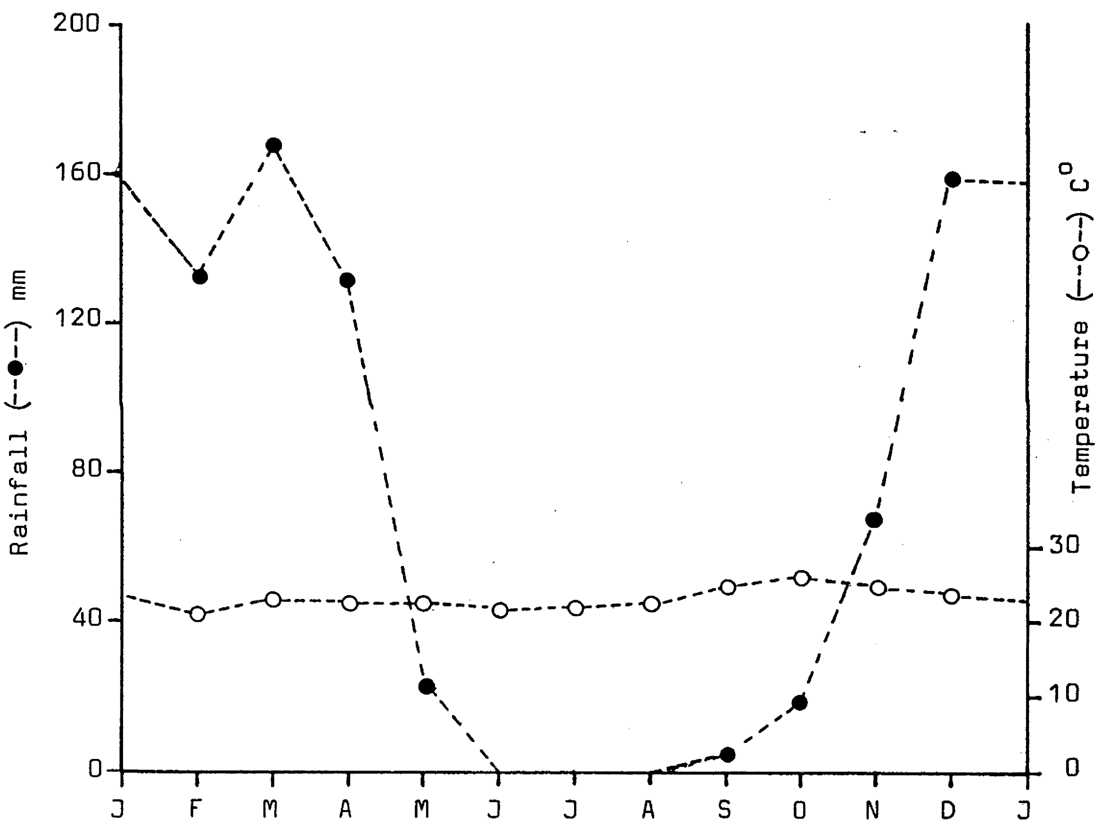


Figure 4.5

Rainfall and temperature data for Dar es salaam in the coastal zone of Tanzania

Location Lat. $06^{o}53'S$ Long. $39^{o}12'E$ Elevation 58m.a.s.l.
(10 years of record)

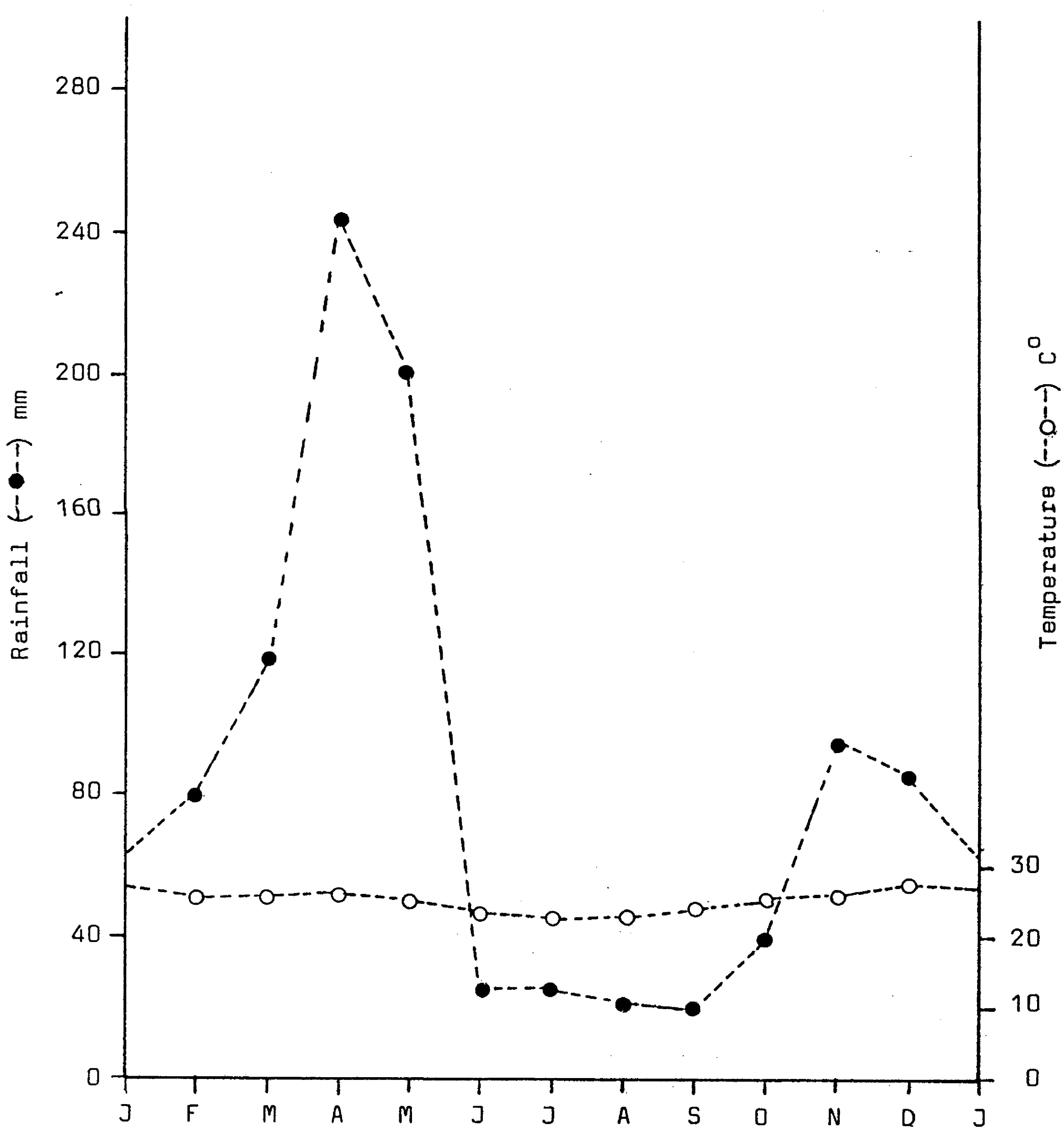
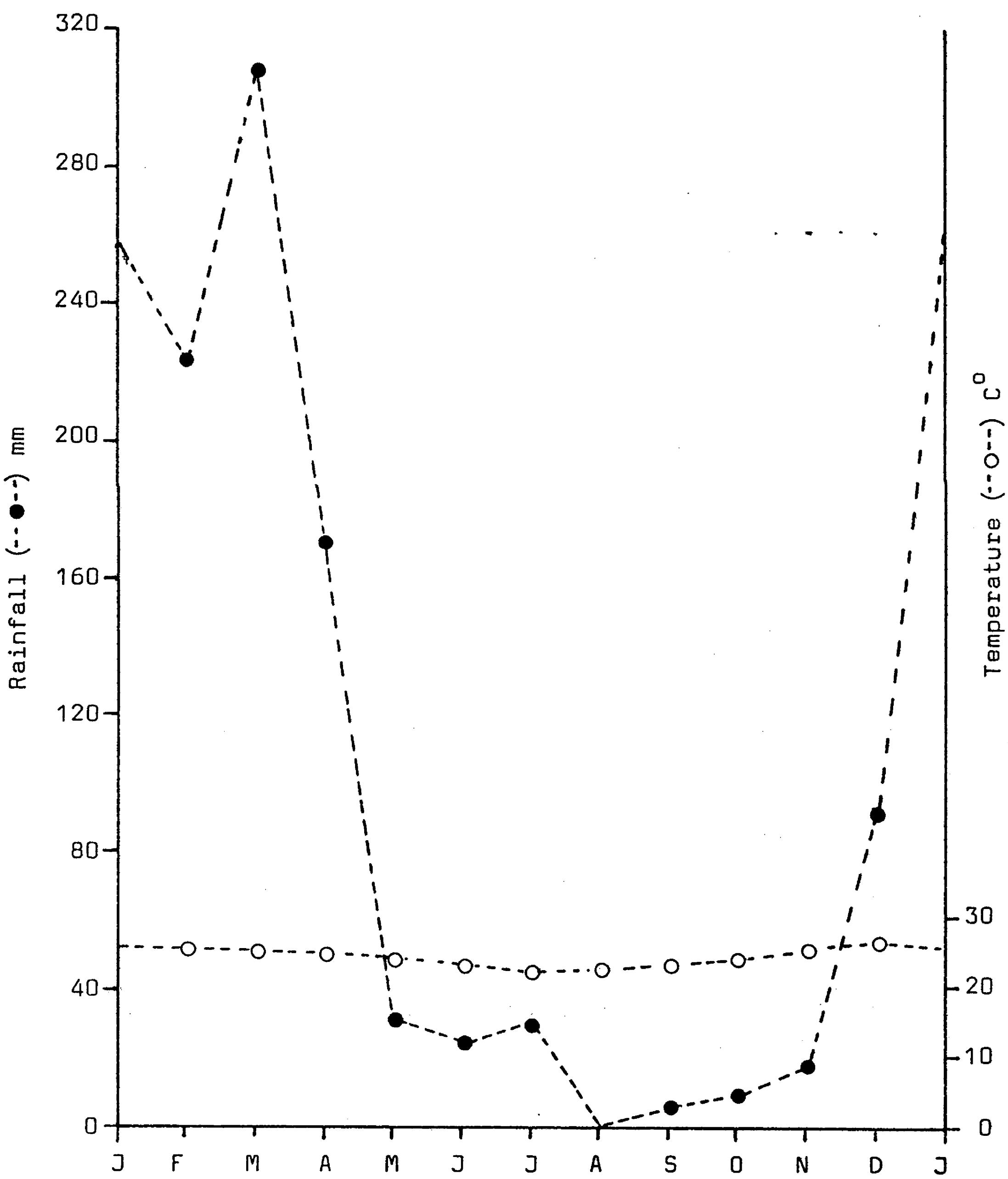


Figure 4.6

Rainfall and temperature data for Mtwara in the coastal zone of Tanzania

Location Lat. $10^{0}16'S$ Long. $40^{0}11'E$ Elevation 113m.a.s.l.
(10 years record)



Silvicultural research in the arid zone is divided into three broad stages; species elimination trials, species growth trials and species plantation trials. The species elimination trials were done mostly theoretically by eliminating species not having many of the silvicultural characteristics considered appropriate for village afforestation. Species growth trials in conjunction with provenance trials were established in many parts of the arid zone by using species selected as appropriate for each area. These trials are well laid out in the field in randomised block designs, with a minimum of 25 trees per plot. The plots are measured annually and they are expected to provide species data on survival, growth and utility characteristics. The species growth trial plots are also used as demonstration plots for villagers.

Established village plantations are also regarded as species plantation trials, where species are tested under plantation conditions. The three stages of silvicultural research are conducted concurrently and experience gained in each stage contributes to the development and adjustment of the others. For example, early fast growth obtained in species growth trials which are properly weeded each year was not obtained in village plantations which are not weeded properly. Production of fuelwood calculated from trial plots cannot be used directly for estimating volume from village plantations; the data must be adjusted due to the factor stated above.

Based on preliminary results from species growth trials, species listed on Appendix 2 are recommended for village afforestation in the different climatic zones of Tanzania. Plates 4.1 to 4.6 show some research activities on species growth trials in the arid zone.

Plate 1

Bush clearing for the establishment of Kigongwe (Dodoma) trial plots in October 1970.

Plate 2

Planting of Kigongwe (Dodoma) trial plots in December 1970

Plate 3

Assessment of Kigongwe (Dodoma) _Cassia siamea_ trial plots, planted in December 1970, in June 1972.

Plate 4

Asssessment of Kigongwe (Dodoma) <u>Eucalyptus</u> <u>tereticornis</u> trial plots planted in December 1970, in June 1972

Plate 5

Survey of Mtipa (Singida) trial plots
in October 1970

Plate 6

Assessment of Mtipa (Singida) Eucalyptus camaldulensis trial plots planted in December 1970, in June 1972

4.5 Some problems encountered in the implementation of village afforestation

Some of the problems encountered in the implementation of village afforestation in Tanzania are discussed below.

(a) Unavailability of seed or use of poor seed

Seed is sometimes not available or is in short supply from the silviculture research station or from other seed sources in the country. To solve the problem, foresters are encouraged to collect seed locally as much as possible instead of relying too much on the silviculture research station which is dealing only with genetically improved seed available in small quantities. Thus silviculture research station seed is expensive and so normally would only be used in special trials. Routine planting has been carried out using locally collected seed, but in some instances the collections were from trees of poor form and the resulting plantation stands are of poor quality.

(b) Unwillingness of villagers to plant trees due to the long rotation

Many villagers are unwilling to plant trees due to the long rotation involved - more than five years in case of even very fast fuelwood species as compared to seasonal agricultural crops like maize and beans. Although most villagers have experience and knowledge of cultivating agricultural crops, they do not have a knowledge of cultivating trees. Increased efforts in forest extension work could minimise such ignorance of forestry production.

Sinden and Schaefer (1968) stated that farmers' attitudes towards farm forestry on the north coast of New South Wales indicated that among the total number of farmers surveyed, 75 percent of them had never heard of farm forestry and 59 percent rejected the issue of planting trees due to its long production period. If the number of farmers ignorant of farm forestry in Australia, with a well established forestry sector and advanced mass media communication systems, is as high as 75 percent, then in less developed countries, like Tanzania, the number of farmers ignorant about farm forestry can be expected to be close to 100 percent. Fast species, like Calliandra calothyrus and Lespedeza species which can produce usable fuelwood at the age of one year, succeeded in minimising the long production period in Indonesia and Korea (Arnold 1978, FAO 1978).

(c) Unavailability of means of transport to extension workers

Unavailability of means of transport greatly hinders the effectiveness of extension workers throughout the country. A forest extension worker is expected to serve an area of at least 10,000 sq km, yet most of the workers do not have any means of transport, not even a bicycle. The government is aware of this problem but capital is a limiting factor. Foreign donors are encouraged to assist in the provision of transport for village afforestation.

(d) Poor tending of village fuelwood plantations

Villagers rarely bother to weed fuelwood plantations. In some cases they do not even weed their own agricultural farms. Along the coastal areas, villagers weed their cashew nut and coconut farms by using fire. Such a practice has been condemned by both agricultural officers and politicians for many years but some villagers are still using fire as a method of weeding. Some villagers therefore expect to use fire as a means of weeding newly planted fuelwood plantations.

As most of the species used for village fuelwood plantations are fast growing Eucalypts, which are very sensitive to weed competition, lack of weeding in these plantations is a critical problem. In Mwanza region it has been reported that 80-90 percent of tree mortality during the first three years of establishment can be attributed to lack of weeding (Mnzava 1980).

Lack of weeding is causing one or more of the following problems in village afforestation:

(i) competition with planted trees for available soil moisture and soil nutrients,
(ii) increased fire danger,
(iii) weeds harbour small animals which may kill trees by debarking, and
(iv) abundance of grasses invite grazing animals which eat the the young trees, as well as the grass.

The above factors slow down growth rate and increase rotation age of planted trees. The general pattern observed in Tanzania since the start of village afforestation is that once trees are planted by villagers there is very little follow-up maintenance given.

(e) Uncontrolled grazing and fires in village fuelwood plantations

Uncontrolled grazing and annual wild fires are some of the main problems encountered in village afforestation. Annual seasonal grassland and bush fires are common in all areas used for grazing. The burning is done purposely to eradicate ticks and to stimulate growth of new grasses. These fires are uncontrolled and they normally sweep through village fuelwood plantations, killing most of the plants.

Grazing in village fuelwood plantations when the plantations are too young to resist animal damage can be attributed to the following factors:

(i) Most of the areas set aside for the establishment of village afforestation are those used for grazing. Grazing is expected to stop once trees are planted in these areas, but graziers rarely do so.

(ii) Most of the areas facing serious fuelwood shortage are also characterised by having large numbers of cattle. Overgrazing and soil erosion are common phenomena in these areas.

(iii) During the dry season, when grasses are normally scarce in most grazing areas, green leaves of young trees present a highly appetizing temptation to foraging animals. Whenever cattle pass near a fuelwood plantation they always rush into the plantation due to the appetizing green leaves of the trees. In most cases individual graziers do not chase their cattle away from the plantation as the probability that another grazier will not do so is relatively high.

(iv) Grazing in many places is done by young boys aged 6 years to 10 years. These young men rarely look after the cattle. They spend most of their time playing or hunting birds. The cattle roam about eating whatever they can without any control. Fuelwood plantations are therefore destroyed by the cattle without the notice of the young men, although they are warned by their parents not to graze in the fuelwood plantations.

(v) Fencing of village fuelwood plantations is not possible due to the high costs involved. Fencing of trial plots also failed in Dodoma and Singida regions as the fencing posts were always uprooted for fuelwood. Proper land use planning could minimise the grazing problem.

(f) Harvesting

The procedures to be followed for harvesting communal village fuelwood plantations and to distribute the wood among the villagers is not known by either village government leaders or foresters. Few village communal plantations, ranging from one hectare to four hectares, have reached rotation age. The volume obtained from these plantations is small in relation to the number of villagers who expect a share. Thus, whenever a village fuelwood plantation is harvested, dissatisfaction and complaints by the villagers are experienced. Those who think they did not get a fair share are normally reluctant in implementing future communal village afforestation projects. Education on how to distribute wood harvested from village plantations fairly could be expected to minimise the problem. The increasing number and size of village plantations will also minimise the problem as a greater volume of wood will be available for distribution.

(g) Social problems

The success of village afforestation is influenced not only by the techniques employed by foresters, but by the daily living habits of the total village population surrounding the village fuelwood plantation. As the small trees planted are both the manufacturing plants and products, destruction of the plants destroys both. Activities of a few individuals who are against village afforestation due to ignorance or carelessness have hindered the success of village afforestation by either setting fire to such plantations or uprooting trees.

The planting of millions of trees and successfully nurturing them to maturity is not a clearly defined task, like building a house or constructing a road. Social impacts within the population which is supposed to protect the plantation, play a vital role in village afforestation.

Most villagers are demoralised significantly when a failure in village afforestation is experienced and they are reluctant to participate in future programs. Enforcement of the protection of village fuelwood plantations by law, accompanied by an increasing awareness of the majority of villagers of the importance of village fuelwood plantations, are expected to minimise social problems contributing to failures in village afforestation.

4.6 Solution to the problems hindering the success of village afforestation

The problems currently hindering the success of village afforestation, a few of which are discussed above, must be solved or minimised in order to ensure successful implementation in the future. Critical initial planning on how to educate farmers on the role of forestry in their socio-economic development so that they will value forestry in the same way as they value agriculture, is considered to be the main aspect for village afforestation success. Most failures are currently caused by lack of proper initial planning on how the whole program is to be implemented from establishment to harvesting stage. For example, foresters are currently concentrating their efforts in raising as many tree seedlings as possible for village afforestation and in persuading villagers to establish communal village fuelwood plantations by planting tree plants issued to them from forest nurseries. This has been achieved successfully throughout the country. However, foresters have put little effort into planning how the newly established communal village plantation would be managed to rotation age, and in assessing the relative concern villagers have for managing the newly established plantation, in relation to their other economic activities like farming. The consequence of this lack of planning is the currently experienced mass failures of newly established communal village plantations mainly due to lack of tending. The next chapter will discuss some planning guidelines to be considered for successful implementation of village afforestation, mainly on ways of carrying out forest extension.

CHAPTER 5

SOME PLANNING GUIDELINES FOR SUCCESSFUL IMPLEMENTATION OF VILLAGE AFFORESTATION

5.1 Introduction

FAO (1978) outlined in a broad spectrum, some planning guidelines for successful implementation of village afforestation programs together with case studies from developing countries. Mnzava (1980) outlined problems encountered in the implementation of village afforestation in Tanzania within the period 1968 to 1978. Smith (1962) has noted that, 'a good silvicultural system is not chosen but formulated as a solution to a specific set of circumstances'. So too Ahn (1978), Arnold (1978), Tewari and Mascarenhas (1980) all strongly recommend that planning guidelines for the implementation of village afforestation should be formulated for each specific area and not generally adopted. The planning guidelines outlined in this chapter, therefore, are specifically formulated to meet the Tanzanian situation.

Many authors have stated that the willingness of villagers to undertake village afforestation depends upon the effectiveness with which forest extension workers can educate them to increase their current agricultural production and to meet more easily their other basic needs through integrating forestry with other development activities (Adeyoju 1978, Atmosoedaryo 1978, FAO 1978, West 1978, Mnzava 1980). Hopefully villagers will accept the message which will lead them to make revolutionary changes in their attitude towards forestry, viewing forestry in a new perspective as a vital part of their future socio-economic development. However, there is a wide communication gap between forest extension workers and villagers (West 1978). This gap can be minimised by intensive planning for the education of villagers on the role of forestry in rural development (Shepherd 1980).

Similarly, Atmosoedaryo (1978) and West (1978) both stated that successful implementation of village afforestation depends mainly upon the willingness of villagers to undertake the work as part and parcel of their socio-economic development. External aid such as provision of seedlings and technology by the Government will accelerate village afforestation programs but should not be considered a pre-requisite for success.

West (1978) further stated that development is something that people seek for themselves in order to achieve liberation from poverty and other socio-economic problems. Development is an individual decision. Without such an individual desire for development it is difficult for any external agency to achieve development success. However, through education, external agencies can assist in making people more aware of their potential capabilities for self development. Mnzava (1980), Tewari and Mascarenhas (1980 indicated that many rural people are ignorant of their own ability to liberate themselves from poverty. Worse still they are not very receptive to outside suggestions such as, for example, those given by Government extension workers. This factor makes extension work in rural areas rather complex, the degree of complexity depending upon the attitude of villagers to the subject matter. Villagers' attitude towards forestry have usually been negative for the following reasons:

(a) forests harbour animals and birds detrimental to agricultural crops,

(b) forests harbour insects, such as the tsetse fly, which are detrimental to livestock and people,

(c) forests provide hiding places for thieves and other enemies of a village,

(d) the extension of farm land, at the expense of forests will be reduced or cease if forests are not to be cleared out, and

(e) from time immemorial, forest products have been collected freely from natural forests without any endeavour by man to manage or re-establish them. Many villagers believe that forests are an inexhaustable, self renewing, natural resource which will continue to be available regardless of utilisation levels.

5.2 Forest extension

Forest extension is an essential component for the success of village afforestation in Tanzania (Mnzava 1980). Sections 4.5(b) to (g) and 4.6 outlined the importance of forest extension for the success of village afforestation. Extension guidelines which could be used in Tanzania will be discussed in this section.

Little work has been done in rural forestry extension and as such it is necessary to adopt general experiences and techniques to the specific aspects of village afforestation (FAO 1978). There has been an extensive sociological research effort in human problems of agricultural development but with an almost total lack of attention to comparable sociological issues in the forestry sector (West 1978). As such, agricultural extension experiences should not be used without modifications in forestry. The author stated that there has been no research based on the special sociological problems involved in village afforestation upon which rational planning strategies could be based. However, a review of the speed of dissemination of research findings and the degree to which these are adopted and applied by village people may help in the formulation of planning guidelines for extension in forestry.

Most village afforestation projects involve a collective adoption by the entire community in contrast to the adoption of decisions which might be made by individual farmers in agricultural innovations (West 1978). Research has amply shown there are always early and late individual adopters of agricultural innovations, the late adopters being influenced by the early adopters (Rogers and Shoemaker 1971). In collective adoption, however, there must be a reasonable consensus achieved and simultaneous adoption. Collective adoption is more difficult to achieve due to problems of co-operative action, collective property rights and the distribution of accrued benefits to the community (West 1978). Thus, there are significant differences in approaches to extension between agriculture and forestry. For collectively adopted projects like village afforestation to succeed, they must reflect the needs of the whole society as well as taking into account local cultural practices in the community.

Extension measures for collective farming in Tanzania's Ujamaa villages have failed in spite of tremendous political backup accompanied by the provision of intensive free technical advice and free inputs like farm tractors, seeds, insecticides and fertilisers (Coulson 1977). If such well supported agricultural projects fail, then forestry projects will be harder to start and to carry through.

The effectiveness of forest extension services is influenced by the quality of the extension workers involved (Adeyoju 1978, Atmosoedaryo 1978, FAO 1978, Mnzava 1980). For the Tanzanian situation, forest extension workers should have at least the following qualities. They should:

(a) be well trained in forestry, preferably with a certificate in forestry,
(b) be acquainted with village organisation and structure,
(c) be conversant with the Tanzanian political system,
(d) be conversant with internal and external factors hindering village development and how such factors can be overcome,
(e) be able to converse,
(f) have an acceptable reputation to the villagers,
(g) be able to learn quickly,
(h) be able to co-operate with other government workers, and
(i) be knowledgeable about all land uses of importance to villagers.

5.3 Extension service methods

Three methods of extension service have been tried in Tanzania. The use of any one of them will depend on the prevailing circumstances. In brief, the methods are as outlined below.

(a) The individual approach

In this method, extension workers attempt to educate individual farmers. The merits of the method are that:

(i) it provides better communication between extension workers and individual villagers,
(ii) it is easy to plan and conduct, and
(iii) it is easy to assess achievements.

The demerits of the method are that:

(i) it requires many extension workers and hence is expensive, and
(ii) it cannot solve group problems.

(b) The group approach

In the group approach, extension workers deal with a group of people, the size of the group being determined by local interest. This is the most convenient method for Tanzanian villagers as people are living in groups. The merits of the method are:

(i) that many people can be educated at the same time,
(ii) group problems can be solved, and
(iii) group members can learn from each other after extension seminars.

The demerits of the method are:

(i) that it requires skilled extension workers,
(ii) it is difficult to plan and conduct due to village group heterogeneity, and
(iii) communication between extension workers and individual villagers is poor. Some villagers just sit quietly and contribute nothing to the seminars. It is difficult to assess the response of such introvert villagers (Tewari and Mascarenhas 1980).

(c) The mass approach

In this approach the extension service is conducted by using the mass communication medium like radio, television, newspapers, booklets and pamphlets. No direct contact with villagers is planned. The merits of the method are:

(i) that many people are covered within a unit time period,
(ii) only a few extension workers are required,
(iii) it gives good support to individual and group extension work, and
(iv) it provides villagers with information outside their local areas.

The demerits of the method are:

(i) it is not possible to assess villagers' response,
(ii) villagers cannot communicate easily with extension workers,
(iii) it covers broad topics rather than specific topics relevant to a specific area,
(iv) it requires very well trained and experienced extension workers, and
(v) it requires a much more sophisticated and well prepared set of scripted and visual material for presentation of large audiences.

Intensive use of the mass media proved very successful in village afforestation schemes in Korea and China (FAO 1978). For the Tanzanian case, an assessment of the effectiveness of the three methods could be done in order to develop future extension planning strategies.

5.4 Initial planning for an extension service

Initial planning on how to implement an extension service for any particular village is vital for success (Arnold 1978, Atmosoedaryo 1978, FAO 1978, Shepherd 1980, Tewari and Mascarenhas 1980). It is better to have no project rather than a failed project, or worse still, a succession of failed projects (FAO 1978). Outlined below are suggested aspects which could be considered in the initial planning.

5.4.1 Collection of relevant data

A list of relevant data which will assist in the initial planning should be made and such data collected. In Nepal and India the use of questionnaires to villagers and to village leaders supplemented by personal contact with about a 10 percent sample of the village households provided village afforestation data suitable for initial planning (Nepal-Australia Forestry Project 1980, Tewari and Mascarenhas 1980).

Depending on the prevailing circumstances, the following data should be collected where possible.

(a) Village history.

(b) Villagers' attitudes towards forestry and social relationships existing at the village which might influence village afforestation. For example, in a Muslim society, females are, in general, not allowed to work with males. In addition, where the distribution of benefits accrued from communal activities might not be fair, villagers might be unwilling to undertake economic communal activities like village afforestation (West 1978).

(c) The potential role of forestry in the socio-economic development of the village.

(d) Development activities currently being undertaken by villagers and information on how the integration of forestry into these activities could accelerate development for the majority of the villagers. FAO (1978) stated that forestry is but one part of a complex of different activities that are required for rural development. Its contribution must be integrated with the rest to be effective.

(e) Demographic statistics of the village. Total population, population growth rate and percentage of the total population capable of undertaking a part in village afforestation.

(f) Climatic data for the village and its influence on tree growth.

(g) A review of past extension work at the village. Better methods for future extension services could then be formulated where earlier extension work has failed.

(h) A review of forest products consumption at the village and where the products are obtained.

(i) Total land area of the village and its potential use.

5.4.2 Data analysis

Collected data should be analysed and appropriate extension strategies for each particular village formulated. The data will form the basis for most extension seminars which will include some discussion of both land use planning and the area to be planted with trees.

(a) Land use planning

Sound development of any country depends on the proper utilisation of its natural resources (Christcon and Stewart 1968). Each country has its own array of natural resources, suited to different forms of use and offering different opportunities for production. This array of natural resources sets the pattern for primary and secondary production. If the pattern of resources is ignored then development of the country will be retarded.

Land is the main economic natural resource for Tanzania (Section 1.2.1) and its proper use is vital for the development of the country. This can be achieved through land use planning which should be done at the national level as poor land use practice in one part of the country can affect other parts practising proper land use through, for example, increased floods. However, micro land use planning for each village should be done in order to formulate appropriate ways of using village land.

In many Tanzanian villages, the land is used for agricultural production, grazing, residential purposes and for other social activities. Forestry is rarely considered by most villagers as a valid form of land use. Forested areas within villages are regarded rather as potential areas for agricultural expansion and grazing and not for provision of fuelwood, poles and other forest products. Forested areas are used communally without restrictions. Villagers are free to harvest whatever they can from the forest to meet their needs.

Afforestation should be integrated carefully with the prevailing land uses of any village to ensure that villagers will obtain the greatest benefit from their land, hence accelerating their development and not the reverse (United Nations 1977, West 1978 and Wood 1980).

By introducing afforestation to a village the pattern of prevailing land use must be modified and this might lead to the loss of certain values enjoyed by some individual villagers (FAO 1978). Unless such individuals are convinced that returns from village afforestation will contribute more significantly to their socio-economic development than the present benefits, they will always object to afforestation. They are most likely to demonstrate their objections by grazing in young village tree plantations or setting fire to such plantations (Section 4.5(d) and (e)).

Foresters should co-operate effectively with village leaders and with all other government experts concerned with village land use so that they can have an integrated and co-ordinated land use plan for each village and for the whole country. Co-ordinated land use planning will minimise or avoid land use conflicts created by Government experts not consulting each other when working with villagers. For example, in some villages foresters have advised farmers to plant trees along their farm boundaries for fuelwood yet, agricultural officers were advising farmers to fell all trees along their farm boundaries to avoid shading their agricultural crops. Co-ordinated planning will minimise such contradictory advice to farmers. Adeyoju (1978), Shepherd (1980) and Wood (1980) strongly emphasised the need for co-ordinated land use planning in all village afforestation programs.

The amount of land to be set aside for village afforestation will depend on the productivity of the available land and on the quantity of forest products required by the villagers now and in the future. The requirements of other land uses within the village should be considered critically in relation to forestry use and foresters should not be biased towards forestry. Thus, multiple land use should be emphasised in all village land use planning as it can minimise the area to be set aside for village afforestation and optimise land use within the village. In many areas, trees are of benefit to agriculture and livestock production for they provide fodder, shelter, shade and improve the microclimate of the local area. Some of the advantages from combining forestry with agriculture and livestock production are outlined below.

(i) Controlled grazing within a forest may be mutually beneficial for the animals can obtain food, at the same time reducing ground vegetation in the plantation which could be a potential source of fire. The animal droppings in the forest will contribute by improving soil fertility. However, animal camps should be located outside the forest to avoid the detrimental concentration of manure in small areas. Unfortunately, controlled grazing in Tanzanian forest plantations has failed. Farmers do not comply with the grazing rules, mainly with regard to grazing capacity. Overgrazing is currently acute in all plantations attempting controlled grazing. In spite of this experience, it should be emphasised that with intelligent co-ordinated land use planning, villagers can increase agricultural and livestock production as well as forestry production through multiple use. For example, introduction of tree intercropping with elephant grass (<u>Pennisetum purpureum</u>) in parts of Central Java, solved overgrazing problems in the forest, increased agricultural and livestock production as well as forestry production (Arnold 1978). The same could be done to solve the Tanzanian overgrazing problem.

(ii) In areas of land scarcity, farmers can integrate agricultural production with forestry successfully by growing trees along farm boundaries, water courses, avenues, around houses and in all areas of little agricultural value. Such a practice has proved very successful in the Kilimanjaro and Tanga regions where trees are interplanted with coffee and banana crops. Many Kilimanjaro farmers practicing such multiple land use are completely self sufficient in fuelwood and small wood materials within their small family farms of about one hectare in size. Such a practice has been very successful in the Punjab and Haryana of India, where over 80,000 km of row plantations have been established (Arnold 1976).

(iii) Trees can improve land fertility if they are scattered over the village. Trees pump up, via the roots to the leaves, nutrients from the lower soil layers, consequently minimising leaching, while the fallen leaves and twigs help to form a compost which retains these nutrients in the top soil layer, hence making them available to agricultural crops and grasses for animal husbandry. In addition, trees provide shade for livestock as well as for people and they act as wind breaks and stabilise the soil hence minimising soil erosion. All these factors assist in minimising soil degradation consequently increasing or sustaining agricultural and livestock production. Openshaw (1979a) indicated that in many parts of Tanzania it will be profitable to cover as much as 5-10 percent of the existing farmland with trees in order to increase the economic return from such land.

(iv) Tree species with multiple uses, mainly for fodder, shade, fuelwood and as nitrogen fixers, are of great importance in the arid areas where grasses for animals are scarce during the dry season. Suitable fodder tree species which might be tried in Tanzania are outlined in Appendix 1.

(v) Intercropping of medicinal plants in forest plantations can assist health services as well as generating income to villagers and to the whole nation. Atmosoedaryo (1978) indicated that intensive intercropping of medicinal plants in Indonesian forests is currently being practiced with success. The author indicated that home demand for medicinal plants is already high and likely to increase since most Javanese take these herbs regularly whenever they do not feel well. Several enterprising capitalists are currently engaged in large scale production of herbal medicines, including exports to neighbouring countries.

Adeyoju (1978) indicated that in Africa, medicinal plants obtained from the forests contributed significantly to local health services, both in rural and urban areas. He stated that a survey carried out in Nigeria indicated that even at the University, in the elitist Ibadan community, a significant segment of the population consumes large quantities of local preparations from herbs, leaves, roots, branches and bark for the treatment of such ailments and conditions as malaria, convulsion, cough, stomach disorders, pneumonia, drowsiness, pregnancies, childbirth and ageing problems. The author also stated that more than half of the prescriptions written by American physicians today contain a plant-derived drug. Myers (1978) stated that all natural materials that go into current contraceptive pills are derived from plants growing in the tropical moist forests, mainly wild yams. The author also stated that the World Health Organisation believes that the most abundant stock of potential antifertility materials occur in the tropical moist forests and intensive research on such plants is currently being conducted by the World Health Organisation.

> In Tanzania it is common to find at least two traditional doctors (herbalists and folk practitioners) in each village. On these grounds it can be estimated that the number of traditional doctors in Tanzania exceeds 20,000, most of them fully employed in the field with sufficient patients to attend each day. The contribution of these traditional doctors to the health of the people is significant. However, little has been done to perpetuate the supply of medicinal plants. Multiple land use will contribute significantly in this field.

In brief, multiple land use will assist in increasing productivity per unit land area and hence in meeting the needs of the growing population as well as increasing wealth. The present situation in Tanzania where livestock experts, agronomists and foresters often look after their own narrow interests, competing more often than co-operating in sensible land use, should be stopped. As emphasised earlier, foresters must co-operate with other professional people involved in land use and form co-ordinated land use planning committees in all villages.

Hofstad (1978) in an endeavour to introduce agrosilviculture into Tanzanian forest plantations made an economic evaluation for combined wood and food production in the Arusha region, with the objective of elucidating the economic importance of multiple land use. His calculations were based on <u>Pinus patula</u> (Mexican weeping pine), <u>Zea mays</u> (maize) and <u>Vicia</u> species (beans) using 1978 market prices. His results indicated that the 'present value' of all future rotations, assuming a rental rate of 5 percent per hectare, was US $1,610 for wood production only and US $5,800 for wood production combined with maize and bean production. If multiple land use could be adopted in most forest plantations in Tanzania, forestry would contribute more to the economic growth of the country than at present. The same can be expected to apply at village level. Atmosoedaryo (1978) emphasised that forestry combined with food production for local communities should be promoted as objectives of forest management.

The few points discussed above illustrate the importance of land use planning as being vital for any village socio-economic development. However, land use planning is rather a complex subject and as such it should be done by professional workers in co-ordinated land use planning committees. Such committees can easily be formed for each region in Tanzania by utilising the many land use related professional workers currently working in the region.

What is required is simply the mobilisation of these professionals. Adeyoju (1978) suggested that foresters could initiate the mobilisation. The objective of the planning should be directed towards meeting village needs and so village leaders should be included in all land use planning. There is a strong tendency for villagers to designate marginal agricultural lands, such as hill tops and slopes for village afforestation (Arnold 1978, FAO 1978). However, Cecelski et al (1979) urged strongly that such lands are, in many cases, also marginal for forestry and they may require sophisticated planting techniques such as deep ploughing for arid land, terracing for steep hills and fertilisation. Such factors are beyond the capability of many villagers to obtain.

Once a land use plan for a village is compiled and accepted for implementation by the majority of the villagers, foresters should start to plan how to use areas set aside for forestry production.

(b) Calculation of area to be planted with trees

Future consumption for fuelwood and small wood materials for domestic purposes will depend on the number of people who need to use them and the availability of other sources of domestic energy. In calculating the area to be planted with trees in order to meet future requirements, the points outlined below should be taken into consideration.

(i) The consumption of fuelwood and small wood materials for an average villager in Tanzania, estimated to be $2.3m^3$ of roundwood per capita per annum (Section 2.2.1). The total amount required for any year can then be estimated once population projections are provided.

(ii) An estimate of the productivity of the land to be used for forestry. This will be dependent on the species to be grown. In most arid zone fuelwood plantations in Tanzania, annual increment per hectare varies between $15\text{-}20m^3$ (Temu 1979, Mnzava 1980).

(iii) The proportion of desired forest products which can be obtained outside the village boundaries, for example, from nearby Government forest plantations or from natural forests.

The area to be planted each year to satisfy future wood requirements can then be calculated by using the formula:

$$A = \frac{B - C}{D \times R}$$

where:

A = Area to be planted in hectares.

B = Estimated total requirement for wood in cubic metres (roundwood) at rotation age.

C = Estimated total amount of fuelwood and small wood materials which can be obtained outside the village fuelwood plantation in cubic metres (roundwood).

D = Estimated annual increment per hectare in cubic metres (roundwood).

R = Rotation age in years.

5.5 Conducting forest extension seminars

5.5.1 Preparation of seminar material

Extension worker(s) should be clear as to the objectives of each seminar and should prepare seminar material well in advance. The venues for seminars should be ascertained well in advance and adequate teaching aids prepared. Participants in seminars should be well informed of the seminar timetable and the duration of each seminar should be fixed. Two hours is a convenient period, as for any longer period participants are likely to lose concentration. Based on 10 years experience in forest extension service in Dodoma, Kigoma, Morogoro, Arusha and Kilimanjaro regions it can be stated that it is worthwhile for extension workers to bear in mind the following characteristics about Tanzanian farmers when conducting extension seminars

(a) Farmers are adults with long experience in their local environment and as such they should not be treated as school children.

(b) The education status of farmers within a village can vary significantly and as such extension services to farmers should be planned to allow for this heterogeneity. Presentation should be simple, based on grassroot information. Use of advanced technical terms and non-local language should be minimised whenever possible.

(c) Farmers learn faster through practical examples than through theory alone. Whenever possible demonstration plots should be established within the village. Alternatively a group of villagers can be given the opportunity to see a demonstration or the actual implementation of projects in nearby villages. FAO (1978) indicated that a lack of managed forests at village level for demonstration purposes is a common constraint throughout the developing world when introducing village afforestation. In Indonesia, demonstration plots were established first in villages by the Government then villagers were urged to follow the same approach (Atmosoedaryo 1978). The author indicated that the demonstration plots contributed significantly to the early success of village afforestation in Indonesia.

Adeyoju (1978) emphasised strongly that, for village afforestation projects to succeed, there must be practical demonstrations through resident experts rather than extension visits; the leadership must be local rather than itinerant. Fast growth of <u>Eucalyptus</u> species at Kigwe silviculture trial plots in Dodoma region induced Kigwe villagers to engage in intensive individual tree planting of <u>Eucalyptus</u> species, for fuelwood and poles (Kaale 1979a).

(d) Farmers are initially sceptical of Government extension workers. Their experience with extension workers in the past has often been rather discouraging. Some extension workers have been arrogant and treated farmers as if they were children. Some have given them the wrong advice which led to failure in agricultural crops and in village afforestation. Farmers view extension workers as people who are working to earn a monthly salary and not motivated to solving their particular problems. Thus it is important to bear in mind the ten points outlined in Section 5.2 regarding the qualities of extension workers for a few bad ones can destroy the reputation of the rest. A good impression from the first seminar is essential for success of future seminars (FAO 1978).

(e) Many farmers do not travel much outside their district or region so local examples should be used in seminars whenever possible.

(f) Farmers are rather reluctant to adopt new production methods which they are not yet convinced will succeed (West 1978). They would rather wait and see than experiment on their own. However, once they are convinced they do accept changes (Tewari and Mascarenhas 1980).

(g) Farmers are interested in projects which will give early returns. They normally think on a short term basis and as such long term projects will not be readily accepted (Section 4.5(b)).

(h) Farmers trust their village leaders more than visiting extension workers. As such, extension workers should co-operate with village leaders in organising extension seminars and discuss with them the appropriate timing to minimise interference with farming activities. Ahn (1978) and Shepherd (1980) emphasised strongly that for rural extension work to succeed, active co-operation from rural leaders is essential.

5.5.2 Topics to be covered

Topics to be covered in each seminar should be prepared in accordance with village circumstances, determined in the initial planning phase. Teaching aids should be used where possible, including posters, pamphlets, booklets, slides and short educational films. Examples of topics to be covered are:

(a) A review of socio-economic problems being experienced by villagers.

(b) Villagers' potential to solve problems hindering their socio-economic development through self-reliance, with or without external aids.

(c) Analysis of the basic needs of villagers and how tree planting can facilitate the provision of such basic needs.

(d) The range of available tree species which can be established successfully at the village and the different products which can be obtained from such tree species. This will enable farmers to decide what type of tree species they would like to plant. Experience in Nepal indicated that farmers prefered fruit and fodder trees such as mango trees (Mangifera indica) to Eucalyptus species or other general fuelwood and pole species (Nepal-Australia Forestry Project 1980).

(e) Establishment methods for the selected species in individual tree plantings and in communal forest plantations. For communal plantations, the following aspects will need to be considered:

(i) Provision of labour for establishment, tending and protection and means of minimising a labour shortage during agricultural peak seasons. In the arid zones the planting season for both agricultural crops and trees is very short and coincidental (FAO 1978). As a result, the availability of labour for tree planting could be restricted. Early ground preparation for tree planting has been suggested as a means of minimising the problem. Table 5.1 shows an estimate of man days required for establishing a hectare of fuelwood plantation.

(ii) The means for dealing with villagers who evade communal work, such as restricting their use of existing communal facilities or by enforcement of village rules.

(iii) The means for protecting village forest plantations from grazing and fire (Section 4.5(e) and (g)).

(iv) Harvesting and regeneration methods to be adopted.

(v) A fair means for distributing end products (Sections 4.5(f) and 5.4.1(v)).

The time needed to cover these topics will depend on the background of the village and the villagers' rate of understanding topics covered in each seminar. A method of assessing the achievement of each seminar would be useful. Extension workers could carry out a random sample survey a few days after each seminar to ascertain villagers' understanding and personal views on the topics covered. Appropriate adjustments could then be made to improve future seminars.

Table 5.1

Estimated man days required for establishing
a hectare of fuelwood plantation

Operation	Mandays
Land preparation	10
Staking and pitting at a spacing of 2.5m by 2.5m (1,600 seedlings per hectare)	10
Planting	4
Beating up	2
Weeding (first year)	16
Weeding (second year)	16
Weeding (third year)	8
Fire protection	8
Harvesting	6
Total	80

Source: Openshaw 1979b

If the points outlined in this section are to be followed, it is clear that extension work will not be a simple task. It is complex and requires well trained workers with a keen interest in rural development for it to succeed. Adeyoju (1978) indicated that a consortium of experts is needed ranging from social anthropologists to extension specialists to assist the communal forestry managers. FAO (1978) stated that the implementation of an extension service for village afforestation is complex, thus requiring well trained manpower with quite different skills than those of traditional forestry.

Professional foresters could plan village extension seminars as they are well trained in economic development, land use planning, advanced silvicultural techniques and other socio-economic aspects affecting rural development. However, due to a shortage of professional foresters, the few existing ones might best be employed in planning and conducting extension seminars to extension workers at the district level. These workers could then conduct extension seminars to villagers. It would be advisable to cover a few villages well rather than many villages in a rush, the latter often leading to failure (FAO 1978).

Extension work should ideally extend beyond the village level (Adeyoju 1978, FAO 1978, Shepherd 1980, Tewari and Mascarenhas 1980). Government ministers, planning commissions, senior government officials, politicians, religious leaders and all other people influencing rural development should be made aware of how forestry can accelerate rural development.

Effective support by these people will assist in forest extension to villagers and in the establishment of village plantations. These people can be educated through public meetings, in parliamentary sessions and through the news media. Foresters should be more active in submitting forestry articles to local and international newspapers.

Another method for encouraging forestry would be to print short sentences encouraging people to plant trees on many commercial commodities circulating in Tanzania, such as paper money, stamps, food packages, match boxes, beer bottles, envelopes and cigarette packets. For example, trees are signs of life, plant a tree before you fell a tree and trees increase food production.

Musicians could be encouraged and rewarded for composing songs which encourage people to plant trees. The same could apply to cultural dance groups. Cinema halls all over the country could be issued periodically with short forestry educational films which can be screened before the start of commercial films. Religious leaders could be asked to encourage their believers to plant trees around their worshipping areas as well as their homes.

The role of school children in village afforestation should not be overlooked. They are the new generation and the future success of village afforestation will rely much upon them. School children are easy to educate and organise and they adopt new technology faster than elderly people. Foresters should participate in educating school children on the importance of forestry in their future life. Each village school could be encouraged to establish and to manage a school woodlot. The products of the woodlot could either be distributed within the village or sold to obtain funds for other educational facilities.

5.6 Institutional and technical aspects

Arnold (1978), FAO (1978) and Shepherd (1980) stated that some of the factors motivating community involvement in local forestry projects require input from outside community sources. Inputs may be needed such as free provision of seedlings, insecticides, fertilisers, technical advice and tools not possessed by the community. The authors indicated experience in Korea, China, Nepal, Sudan, India and Indonesia revealed that the greater the Government commitment, the greater the achievements seem to be. They stated that if village afforestation projects are to succeed, continuous Government support is obviously needed in financial, research, extension and management fields.

Foreign donors are strongly encouraged to support village afforestation projects since they could really assist in solving grassroot socio-economic problems (Byron 1980). The Australian Government aid to the Nepal community forestry project can be cited as a good practical example (Shepherd 1980). Table 3.1 outlines some of the foreign donors assisting Tanzania in village afforestation programs.

Arnold (1978), Shepherd (1980) and Slee (1980) stated that technical aspects required for the success of village afforestation concerned the selection of appropriate species, methods and techniques which should be well tried beforehand and easily understood by the local people (Section 4.4). However, these authors also emphasised strongly that unsuccessful projects could jeopardise future participation by the local community.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 Summary

The objective of this study is to formulate general planning guidelines for village afforestation in Tanzania. The study commences with a review of literature on the use of fuelwood and establishment of community forestry in developing countries. Experience gained in these countries might be useful in providing guidelines to solve the problems encountered in Tanzania.

Village afforestation is a government based rural development program in Tanzania, organised to foster self-reliance. Farmers are encouraged to plant trees, either on a communal basis or individually, to meet requirements for fuelwood and small wood materials, both currently in acute shortage. The government provides free seedlings and technical advice while villagers provide land and labour.

Tanzania has a total land area of 887,000 square kilometres and a population of 17,500,000 people (1978 census) with an average population growth of 3.4 percent per annum. The economy of the country is based mainly on the agricultural sector, which contributes about 40 percent of the GNP and approximately 80 percent of the export trade. Income per capita per annum is about US $150. Rainfall is variable and only about 24 percent of the country can expect more than 750mm of rainfall per annum.

In Tanzania, fuelwood accounts for 97 percent of the total forest products consumed and of this, natural forests contribute about 99.87 percent. It is estimated that over 500,000 hectares of woodland are cleared each year for the provision of fuelwood without any regeneration taking place. Thus an acute shortage of fuelwood in the future is inevitable unless intensive tree planting is undertaken to replace the cleared woodlands. From 1973 to 1978, about 22,991 hectares of fuelwood plantations were already planted in different villages.

However, the success rate in the establishment of these plantations has been below 30 percent due to unwillingness of villagers to tend and protect the planted trees. Future success will therefore depend on proper initial planning on how to overcome problems experienced in the past.

In most developing countries fuelwood is the main source of domestic energy for both rural and urban households. More than 86 percent of all the wood consumed annually in these countries is used as fuelwood. Low income and poverty are the main factors forcing most people to rely heavily upon fuelwood as their source of domestic energy. Consumption of fuelwood per capita per annum varies signficiantly from country to country, for example $0.2m^3$ for Burundi to $2.3m^3$ for Tanzania. The variation is caused by the physical availability of fuelwood and the amount of time which must be spent collecting the fuelwood. In general consumption is high where wood resources are still abundant and low where wood is scarce.

The quantity of fuelwood consumed by the poor is frequently described as 'inelastic' in the sense that, regardless of income level, it is a basic necessity for survival. However, the requirement for fuelwood often exceeds supply, giving rise to many socio-economic problems. These include deforestation which can lead to desertification, inefficient use of available labour, antagonism between villagers and officials designated to protect forested lands, burning of animal dung and farm residues better suited to use for agriculture.

In spite of the fuelwood scarcity in many developing countries, it is often used inefficiently. The efficiency of most traditional African kitchen fireplaces is estimated to be about 7 percent only. Development of more efficient cooking stoves will reduce significantly the present consumption of fuelwood. However, such efficient stoves should be constructed from readily available local materials, easy to construct and easy to use with existing utensils owned by villagers.

Conversion of fuelwood to charcoal involves energy losses in the process of manufacturing the charcoal. The energy recoverable from converting wood to charcoal in earth kilns is about 25 percent of the original wood, however, if portable steel kilns or brick kilns could be used, the energy recoverable could be increased to 50 percent. In spite of the loss of potential heat energy in the conversion of wood to charcoal, there are circumstances where this conversion will be desirable, mainly when it has to be transported over long distances or where land clearing is taking place and the forest is being burnt.

Renewable energy sources, like hydro-electricity, biogas, solar energy and windmills, can contribute to domestic energy demand in the long run. Forecasts of future energy supply and demand situations should not neglect these sources but, as they mostly involve high cost and sophisticated technology, they should not be given too much weight.

Village afforestation in Tanzania was started in 1968, when the government considered the provision of domestic energy to the people as an important aspect for development. To incorporate village afforestation into the system, various organisational changes were needed in the Tanzania government forest division which included:

(a) amendment of the Tanzanian government forest policy to incorporate village afforestation for the supply of fuelwood and small wood products to villagers as an objective,
(b) increase of the intake of forestry students by more than 200 percent in order to overcome manpower shortage for the implementation of village afforestation, and
(c) the start of intensive research on fuelwood and pole species with multiple uses.

However, the implementation of village afforestation in Tanzania has encountered the following problems:

(a) shortage of seeds for appropriate fuelwood and pole species,
(b) unwillingness of many villagers to plant trees due to their long production period,

(c) the effectiveness of extension workers is greatly hindered by unavailability of means of transport,

(d) villagers rarely bother to weed and protect fuelwood plantations once planted, also uncontrolled grazing and wild fires are common, and

(e) the procedure to be followed for harvesting communal village fuelwood plantations and means of distributing the end products fairly to those who participated is not yet known.

Initial planning on how to minimise the problems currently encountered is considered a vital aspect for success. Planning guidelines specifically formulated to meet the Tanzanian situation are outlined. However, detailed planning guidelines for successful implementation of village afforestation should be formulated for each specific area and not generally adopted.

Successful implementation of village afforestation depends mainly upon the willingness of villagers to undertake the work as part and parcel of their socio-economic development. The willingness is influenced by the awareness of villagers on the role of forestry to their development. However, studies on farmers' attitude towards forestry have shown that many farmers are ignorant of how forestry can accelerate their development. An intensive forest extension service has been suggested as vital in educating farmers on how forestry could accelerate their socio-economic development and hence increasing their willingness to implement village afforestation.

Effective implementation of forest extension is complex and requires intensive initial planning and should be implemented by well trained workers in collaboration with village leaders. Afforestation should be integrated carefully within the prevailing land uses of any village to ensure that villagers will obtain the greatest benefits from their land, hence accelerating development. Foresters should co-operate effectively with village leaders and with all other government experts concerned with village land use, so that they can form a co-ordinated land use plan for each village and for the whole nation. Multiple land use and use of tree species with multiple uses should be emphasised as they can minimise the area to be set aside for forestry and optimise land use within the village.

Extension worker(s) should be clear as to the objectives of village forestry when conducting seminars and be well prepared in advance. Topics should be in accord with village circumstances determined in the initial planning phase. These might include a review of socio-economic problems being experienced by villagers, villagers' potential ability to solve such problems through self-reliance, with or without external aid, and how tree planting can facilitate the provision of basic needs.

Extension work should ideally extend beyond the village level. Politicians, senior government officials and all other people influencing rural development should be made aware of how forestry can accelerate rural development. School children should be given instruction on the importance of forestry in their future life.

Continuous Government support is obviously needed in financial, research and management fields if village afforestation projects are to succeed. Village afforestation experience in Korea, China, Nepal, Sudan and Indonesia has revealed that the greater the Government commitment, the greater the achievements seem to be. On the technical side, success depends upon the selection of appropriate species, methods and techniques which should be well tried beforehand and easily understood by the local people.

6.2 Conclusion

The following can be concluded from the study:

(a) Fuelwood will continue to be the main source of domestic energy in Tanzania in the near future. Acute shortages of fuelwood and small wood materials are inevitable due to amount and intensity of clearing of natural forests. The fuelwood scarcity will render more serious a number of socio-economic problems, mainly soil degradation accompanied by reduction in agricultural production, which could lead to food shortages for the rapidly increasing population.

(b) Intensive tree planting throughout the country must be undertaken as an integral part of socio-economic development. This will only be achieved by:

(i) making the national and village leaders aware of the benefits of forests and forest products as part of balanced development,

(ii) establishing an effective cadre of trained extension workers who can communicate effectively with village people the benefits of, and methods for, developing village forestry.

References

Adeyoju S.K. (1978). People's participation in forestry for local community development. Eighth World Forestry Congress. Jakarta, Indonesia. FRC/1-0. 24p.

Ahn B.W. (1978). Village forestry in Korea. Eighth World Forestry Congress. Jakarta, Indonesia. FRC/1-5. 11p.

Arnold J.E.M. (1976). Wood for Energy. Mimeo FAO, Rome.

Arnold J.E.M. (1978). Wood energy and rural communities. Eighth World Forestry Congress. Jakarta, Indonesia. FRC/3-0. 31p.

Arnold J.E.M. and Jongma J. (1978). Fuelwood and charcoal in developing countries. Unasylva 29 (no. 118): 2-9.

Atmosoedaryo S. (1978). The importance of forests for rural communities. Eighth World Forestry Congress. Jakarta, Indonesia. FRC/0-3. 15p.

Banerjee A.K. (1979). Local needs of small timber and fuelwood in India. pp.92-103 in Shepherd K.R. and Richter H.V. (Eds). Forestry in national development: production systems, conservation, foreign trade and aid. Development Studies Centre, Monograph no. 17, The Australian National University. 245p.

Brown W. (1977). Assessment of land use in villages around the capital city of Dodoma. Bralap - University of Dar es salaam - Research Report no. 23 (new series). 77p.

Burley J. (1980). Selection of species for fuelwood plantations. Commonw. For.Rev. 59: 133-147.

Byron R.N. (1980). International trade and development economics lecture notes to Master of Science students in Forest Management by Course Work. Department of Forestry, The Australian National University, Canberra. Unpub.

Cecelski E, Dunkerley J, Ramsay W. and Mbi E. (1979). Household energy and the poor in the third world. Research paper R-15. Resources for the future. Washington D.C. 134p.

Coulson A. (1977). Whatever happened to Ujamaa. New Internationalist. No. 48, February 1977: 17-19.

Earl D.E. (1975). Forest Energy and Economic Development. Clarendon Press Oxford. 128p.

Eckholm E. (1975). The other energy crisis: Firewood. Worldwatch paper No. I. Washington D.C: 1-21.

Europa. (1980). Africa South of the Sahara 1979-1980. Europa Publication Limited. London: 1023-1054.

FAO (1976). Conservation in arid and semi arid zones. FAO conservation guide No. 3. Rome. 125p.

FAO (1977). Savanna Afforestation in Africa. Rome. 312p.

FAO (1978). Forestry for local community development. FAO Forestry Paper No. 7. Rome. 114p.

FAO (1979). Yearbook of Forest Products 1966-1977. Rome. 462p.

FAO (1980). Yearbook of Forest Products 1967-1978. Rome. 428p.

Ferguson I.S. (1980). Forest planning lecture notes to Master of Science students in Forest Management by Course Work. Department of Forestry, The Australian National University, Canberra. Unpub.

Fleuret C.P. and Fleuret A.K. (1978). Fuelwood use in a peasant community: A Tanzanian case study. The Journal of Developing Areas 12 (April 1978): 315-322.

Gifford R.M. (1979). Reflections on the social impact of the rising atmospheric carbon dioxide concentration. p.147-150 in Diesendorf M. (Ed). Energy and People. Society for Social Responsibility in Science (ACT) Canberra. 176p.

Goor A.Y. and Barney C.W. (1976). Forest Tree Planting in Arid Zones. The Ronald Press Company, New York. 504p.

Guillard J.P. (1978). Forestry for rural communities: Conspectus and research opportunities. Eighth World Forestry Congress. Jakarta, Indonesia. FRC/IURFO. 16p.

Hofstad O. (1978). Preliminary evaluation of the Taungya system for combined wood and food production in North Eastern Tanzania. Division of Forestry, University of Dar es salaam, Morogoro, Tanzania. Record No. 12. 14p.

Howe J.W. and Gulick F.A. (1980). Fuelwood and Other Renewable Energies in Africa. The Overseas Development Council, Washington D.C. 43p.

Kaale B.K. (1979a). Forest extension lecture notes. Olmotonyi Forestry Institute, Tanzania. Unpub.

Kaale B.K. (1979b). Introductory Notes on Soil Science to Foresters. Olmotonyi Forestry Institute, Tanzania. 103p.

Kaul R.N. (1970). Afforestation in Arid Zones. Dr W. Junk. N.V. Publishers, The Hague. 435p.

King K.F.S. (1975). Forest policies and national development. Unasylva 27 (no. 107): 9-13.

Mnzava E.M. (1980). Village Afforestation: Lessons of Experience in Tanzania. FAO. Rome. 62p.

Mushi J.A. (1978). Growth of Eucalyptus at Ruvu, Tanzania. Silviculture Research Note No. 31. The Silviculturist, Lushoto Tanzania. 11p.

Mushi J.A. (1980). Performance of Eucalyptus species: Provenances established in arid areas of Tanzania. The Silviculturist, Lushoto, Tanzania. 18p.

Myers N. (1978). Forests for people. New Scientist 21/28 December 1978. Vol. 80, No. 1134: 914-976.

Nepal-Australia Forestry Report 1980. Community and Forestry Development. A study of villagers' attitude towards forest and forestry development in Sindhupalchok District of Nepal. Survey Report by New Era, Kathmandu, Nepal. Limited Distr. 106p.

Openshaw K. (1971). Present consumption and future requirements of wood in Tanzania. FO-SF/TAN 15, Technical Report 3. FAO. Rome.

Openshaw K. (1977). The energy problems and requirements of Dodoma region. A report to the Capital Development Authority, Division of Forestry, University of Dar es salaam, Morogoro, Tanzania. 8p.

Openshaw K. (1978). Woodfuel - a time for re-assessment. Natural Resources Forum 3(1): 35-51.

Openshaw K. (1979a). Animals and trees: food for thought. Tanzanian Veterinary Bulletin 1 (November 3). 8p.

Openshaw K. (1979b). A comparison of metal and clay charcoal cooking stoves. Division of Forestry, University of Dar es salaam, Morogoro, Tanzania. 19p.

Openshaw K. (1980a). Rural energy consumption with particular reference to the Machakos District of Kenya. Division of Forestry, University of Dar es salaam, Morogoro, Tanzania. 14p.

Openshaw K. (1980b). Energy requirements for household cooking in Africa with existing and improved cooking stoves. Division of Forestry, University of Dar es salaam, Morogoro, Tanzania. 10p.

Panshin A.J, Harral E.S, Bethel J.S. and Baker W.J. (1962). Forest Products. Their Sources, Production and Utilisation. McGraw Hill Book Co, New York. pp.281-94.

Rogers E.M. and Shoemaker F.F. (1971). Communication of Innovations: A Cross-cultural Approach. 2nd edition. The Free Press, New York.

Shepherd K.R. (1979). Energy from the forests: an exercise in community forestry for developing countries. p.77-91 in Shepherd K.R. and Richter H.V. (Eds). Forestry in national development: production systems, conservation, foreign trade and aid. Development Studies Centre Monograph no. 17, The Australian National University. 245p.

Shepherd K.R. (1980). Tropical silviculture lecture notes to Master of Science students in Forest Management by Course Work. Department of Forestry, The Australian National University, Canberra. Unpub.

Sinden J.A. and Schaefer N.T. (1968). Farmer attitudes to farm forestry on the North Coast of New South Wales. New England University, Armidale, NSW. 7p.

Slee M. (1980). Tropical silviculture lecture notes to Master of Science students in Forest Management by Course Work. Department of Forestry, The Australian National University, Canberra. Unpub.

Smith D.M. (1962). The Practice of Silviculture. John Wiley and Sons, New York. 578p.

Soedarwono H. (1979). Forestry under conditions of population pressure in Indonesia. p.104-115 in Shepherd K.R. and Richter H.V. (Eds). Forestry in national development: production systems, conservation, foreign trade and aid. Development Studies Centre Monograph no. 17, The Australian National University. 245p.

Stewart G.A. (Ed) (1968). Land Evaluation. Macmillan, Australia: 1-28.

Tanzania Forest Division (1980). Implementation of Village Afforestation 1973-1979. Forest Headquarters Dar es salaam. Unpub.

Temu B.A. (1979). Fuelwood scarcity and other problems associated with tobacco production in Tabora Region, Tanzania. Division of Forestry, University of Dar es salaam, Morogoro, Tanzania. Record No. 12. 22p.

United Nations (1977). Desertification: Its Causes and Consequences. Pergamon Press. 448p.

West P.C. (1978). Some sociological aspects of forestry community development projects in developing countries. Eighth World Forestry Congress, Jakarta, Indonesia. FRC/1-4. 7p.

Westoby J.C. (1962). The role of forest industries in the attack on economic underdevelopment. Unasylva 16(4): 168-201.

Westoby J.C. (1978). Forest industries for socio-economic development. Eighth World Forestry Congress, Jakarta, Indonesia. FID/GS. 12p.

Wood G.B. (1980). Land use planning lecture notes to Master of Science students in Forest Management by Course Work. Department of Forestry, The Australian National University, Canberra. Unpub.

World Bank (1977). Tanzania Basic Economic Report (for official use only) 192p.

Appendix 1

Suitable Tree Species for Fodder which could be tried in Tanzania

Species	Remarks
Aegel marmolosa	A fruit and fodder tree.
Ailanthus excelsa	A tree that goats will not touch unless they are trained to eat it. It stimulates milk production when fed to goats. Requires a minimum rainfall of approximately 600mm per year.
Atriplex nummularia	Requires as little as 150-200mm of rainfall per year. Can produce 8-10 times more than pasture under similar conditions. Contains digestible protein averaging 12 percent of dry matter.
Bauhinia racemosa	Used for human and cattle consumption. Its flower buds may be used as a vegetable.
Brosimum alicastrum	Tolerant to drought. Cattle enjoy leaves and branch tips. Abundant fruit used for pig feed. Branches can be lopped regularly. Fodder considered equal to best pasture.
Cassia sturtii	Grows well with only 200-250mm of rainfall per year, producing about a tonne per hectare of dry matter in two grazing periods. Shows around a 12 percent protein content which is similar to that of alfalfa.
Dalbergia sissoo	Good for charcoal and fodder.

Appendix 1 (continued)

Species	Remarks
Leucaena leucocephala	An excellent animal feed, which may also be used for human consumption. It is drought resistant and prefers elevations below 500m, and needs non acid soil.
Parkia clappertoniana	A farm tree with edible pods.
Ziziphus manritania	An arid zone shrub producing a valuable edible fruit the size of an apple.

Source: Openshaw 1979a; FAO 1978

Appendix 2

Some tree species performing well in the different climatic zones of Tanzania

(a) Highlands. The data are for the first 20 years after planting.

Species	Mean annual height increment (metres)	Average survival (percent)	Remarks
1. Eucalyptus saligna	1.50	85	Widely used in large scale government plantations for poles and fuelwood
2. Eucalyptus maidenii	1.85	85	"
3. Eucalyptus regnans	2.50	80	"
4. Eucalyptus citriodora	2.30	80	"
5. Grevillea robusta	1.65	90	Used widely as shade tree to coffee and tea plantations. Sawn timber, poles, fuelwood, fodder, honey production and for shade
6. Acacia melanoxylon	1.20	75	Poles and fuelwood. Planted widely in government plantations for poles and fuelwood
7. Acacia mearnsii (black wattle)	1.45	85	Widely used in large scale plantations for poles, fuelwood and tanning
8. Maeopsis eminii	1.40	80	For sawn timber mainly

(b) Arid zone. The data are for the first 8 years after planting.

	Species	Mean annual height increment (metres)	Average survival (percent)	Remarks
1.	<u>Eucalyptus</u> <u>camaldulensis</u>	0.90	85	Performing well in all trial plots
2.	<u>Eucalyptus</u> <u>microtheca</u>	0.65	90	Stem form rather crooked
3.	<u>Eucalyptus</u> <u>papuana</u>	0.56	95	
4.	<u>Eucalyptus</u> <u>tereticornis</u>	0.68	60	High survivals are experienced in valleys and wetter areas
5.	<u>Eucalyptus</u> <u>tereticornis</u> <u>var</u> <u>C.</u> <u>Zanzibar</u>	0.85	70	
6.	<u>Eucalyptus</u> <u>alba</u>	0.59	60	
[illegible]	<u>Cassia</u> <u>siamea</u>	0.60	80	Young leaves and flowers may be used in curries for human consumption and also fodder to animals
8.	<u>Syzygium</u> <u>jambolana</u>	0.60	90	Edible fruits, fodder, shade, wind break, fuelwood, poles
9.	<u>Mangifera</u> <u>indica</u>	0.40	90	Edible fruits, fodder, shade, wind break, timber, fuelwood
10.	<u>Tamarindus</u> <u>indica</u>	0.30	80	"

Appendix 2(b) (continued)

Species	Mean annual height increment (metres)	Average survival (percent)	Remarks
11. Azadirachta indica	0.40	85	Shade, fuelwood, medicinal purposes
12. Schinus molle	1.00	85	Shade, fuelwood, wind break
13. Grevillea robusta	0.70	85	Sawn timber, poles, fuelwood, shade, fodder, honey production
14. Gmelina arborea	0.40	60	A utility hardwood, cattle eat the fruits, flowers give a good honey
15. Albizia lebbek	0.22	60	
16. Delonix regia	0.50	80	Shade and ornamental, fuelwood
17. Acacia tortilis	0.50	80	Fodder, edible pods, poles, fuelwood
18. Acacia albida	0.50	60	"

(c) Coastal zone. The data are for the first 15 years after planting.

	Species	Mean annual height increment (metres)	Average survival (percent)	Remarks
1.	*Anacardium occidentale*	0.40	90	Well established along the coast. Used for fruits, shade, poles, fuelwood
2.	*Casuarina equisetifolia*	0.50	90	Fuelwood, poles and ornamental
3.	*Mangifera indica*	0.40	85	Fruits, fodder, shade, poles, fuelwood, timber, wind break
4.	*Eucalyptus camaldulensis*	2.09	60	Poles, fuelwood
5.	*Eucalyptus alba*	1.44	80	"
6.	*Eucalyptus tereticornis*	1.56	80	"
7.	*Eucalyptus grandis*	2.47	72	"
8.	*Eucalyptus robusta*	2.47	60	"
9.	*Eucalyptus tereticornis var C. Zanzibar*	2.09	60	"
10.	*Tectona grandis*	1.98	85	Sawn timber, poles, fuelwood